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Mining Journal

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Churn-Drill Prospecting at Morenci, Ariz.

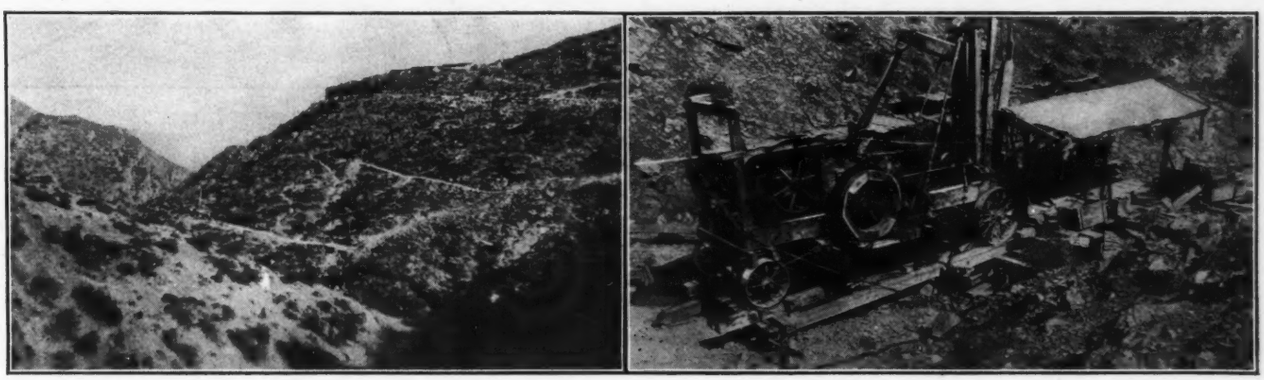
By William R. Grunow*

SYNOPSIS—Churn-drill field laid off in 200-ft. squares and roads built so that an equal number of holes would be on each machine road. Method of drilling, electric operation, sampling and keeping records described. During 12 months, 51 holes, aggregating 37,025 ft. were drilled with four machines. The average cost for the year was $2.048 per ft. Total cost for the period, including original cost of machines, was $3.257 per ft.

During the month of June, 1914, the Detroit Copper Mining Co., of Morenci, Ariz., began the prospecting by means of churn drills of a number of claims situated about three-quarters of a mile to the north of Morenci. The first step was the laying out of the holes. The country to be drilled was surveyed into 200-ft. squares and the corners accurately located by a corner stake and reference point. As shown on the map, one corner, "G.4," was made to coincide with the Idaho shaft, and the coördinate axes were then shifted about this point as a center, so that the lines would follow the contours as nearly as possible. With the completion of the survey, the work of connecting the various corners by a system of roads was begun. As four machines were to be used, the problem became one of so connecting the corners as to bring as nearly as possible an equal number of them in each of four roads. How this was accomplished may be best understood from the map.

The cutting of the fifty-odd stations, in many cases, in solid rock, and the building of more than 16,000 ft. of connecting roads, up and down and around steep hillsides, necessitated considerable blasting and excavation. This preliminary work was accomplished by a Mexican boss and a gang of from 6 to 15 laborers, under the direction of both the drill foreman and the chief sampler.

Four Armstrong No. 22 drills were purchased, without engines and traction attachments, to carry on the work, and each was completely equipped with drilling and fishing tools. These machines, fitted with several improvements suggested by the requirements of the service, have proved to be very satisfactory. An interesting feature of the work was operating the machines by electricity. This was determined upon because electric power was close at hand, and on account of the high cost of fuel and the difficulties that would arise from attempting to distribute it to the various drills in sufficient quantities. Power at 250 volts was supplied to each rig from a substation in which was a motor-generator set taking alternating-current power at 2,200 volts from one of the company's high-tension lines which runs across the field. On the switchboard were circuit-breakers and fuses to guard against lightning and those excessive overloads which are likely to occur in this class of work. From the switchboard, lines were run out to the rigs, at all of which the system of wiring was similar.



VIEWS IN CHURN-DRILL FIELD AT MORENCI, SHOWING DRILL ROADS, CAMP AND DRILL JIG

Before being hauled out to the field, each drill was furnished with a 25-hp. direct-current adjustable-speed motor of the following rating: 230 volts, 94 amperes and 400-1,200 r.p.m. Circuit-breakers and fuses were provided at each machine, in addition to those at the substation. The motor was bolted to the frame directly over the front wheels. The controller and circuit-breakers during the first few months of the work were mounted on a separate frame, which stood on the platform at the

*Mining engineer, Detroit Copper Mining Co., Morenci, Ariz.

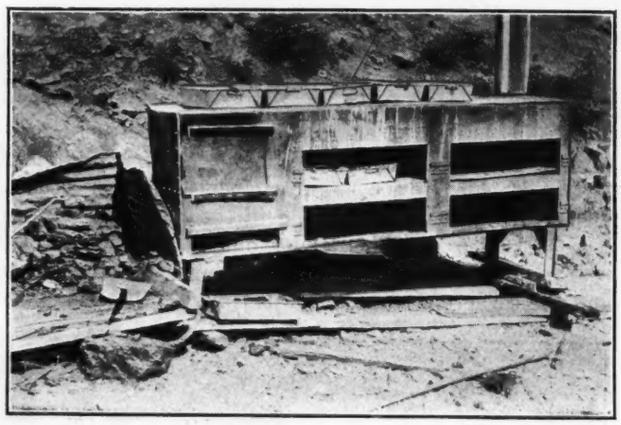
rig. This was done because it was thought that the constant jarring and vibration of the machine would soon shake them to pieces; but the extra trouble caused by this arrangement while moving and the sacrifice of floor space on the platform led to the experiment of attaching these appurtenances directly to the frame of the machine by bolting the controller to the rear end of the frame, the circuit-breakers directly overhead and the resistance along one side. This change, bringing as it did all operating levers and handles within easy reach, resulted in a convenient arrangement for the driller; and no ill effects due to jarring and vibration were experienced. A system of gearing of 7 : 1 reduction transmitted the power to a pulley, which was belt-connected to the band-wheel. This band-wheel was provided with three friction surfaces, upon one of which the friction pulley for the main hoist engaged and upon another that for the sand reel. A friction clutch engaging upon the third controlled the spudding and drilling mechanisms. In addition to the main drive motor, a 2½-hp. direct-current motor was installed at each rig to operate the blower for the forge. This was belt-connected to a No. 2 Sturtevant fan, and the two were mounted on a sled, thus facilitating transportation while moving.

Method of Moving Machines

The machines were moved from hole to hole in the following manner: An iron stake was driven into a hole previously hand-drilled in the solid rock; around this a ⅝- or ¾-in. wire cable was fastened, the other end being wound around the main hoisting drum. Steep grades were negotiated by means of double or triple blocks. Upon arriving at a station, the machine was jacked into position and leveled up. Following this the platform was laid, the mast raised and the sheds erected. Then all the rest of the equipment (forge, fan, wrenches, tools, etc.) was hauled in. The average length of moves, or average distance between stations, was 150 ft. With both crews working together while moving, which was the custom, it would generally take from 2½ to 3 shifts from the time one hole was left until spudding was begun in the next. The hole was always started as soon as possible, the day-shift crew doing the drilling and the night crew finishing the rigging up.

The depth to which the spudding attachment was used ranged from 90 to 120 ft., depending upon the driller. Old rope in 300- or 400-ft. lengths was always used for this purpose. When the change to the walking beam was made, the spudding line was usually taken off and either discarded or saved for future use, and at the same time a new line or one in good condition was reeled on. As in the case of the change from spudding to drilling, the jars were included into the drilling string at various depths. Some of the men preferred to use them when drilling was started, while others waited until it became necessary to use them. Of the different sizes of tools on hand—10¾-in. size, 8¼, 6¼ and the 4⅞—the 8¼-in. was the most used, because it was a convenient size with which to start a hole, gave good footage returns and afforded a large sample. The 10¾-in. size was usually employed only when caving ground was anticipated, though later on holes were put down to a couple of hundred feet with this size bit where 8¼-in. casing was to be lowered with a view to saving the cable. The 6¼-in. size was much used, but chiefly in holes started with tools of larger size. The 4⅞-in. tools were used chiefly in those holes which it was desired to keep going to greater depth, but in which the use of the larger sizes was prevented, either through crookedness of the hole or the caving of the ground necessitating the lowering of 5-in. casing.

While most of the drilling has been done with 2-in. hemp cable, about 3,000 ft. have been drilled with wire line. Of the latter, several sizes—⅝, ¾ and ⅞-in.—have been used. The ⅝ and ⅞-in. cables were discarded hoisting cables from the mines, but the ¾-in. size, practically all of which was "California Special Wire Drilling Cable," has given good results in drilling from depths around 300 or 400 ft. to 700 ft. and beyond. It was especially valuable in wet holes of small section. As may be imagined, the hemp cable was much preferred by the drillers, except in the case mentioned. The use of wire line in short holes brought forth many complaints from the majority of the men, who maintained among other things that they could not "get the motion," could not get the tools to turn, and also that they could not prevent breaks by guarding against dangerous places in the line as readily as with hemp cable. In order to arrive at a satisfactory conclusion regarding their relative merits, the comparative initial costs of the cables and the feet discarded per foot of hole drilled must be taken into consideration and a detailed study made of the time required for performing such operations as splicing, filling sockets, etc., with both kinds of cable. Up to June 1, 1915, every foot of hole drilled by hemp cable had rendered useless for further drilling 0.67 ft. of hemp line. The corresponding figure, 3.99 ft. for ¾-in. wire line, however, is based on data collected during too short a period and for too limited a footage to serve as a reliable basis of comparison.



STOVE FOR SAMPLE DRYING

During the first ten months the work was divided into two parts and carried on under the supervision of two departments. The initial work was in charge of a drill foreman, whose duty it was to superintend the actual drilling operations and to strive for a high footage. The final work was in charge of a chief sampler, who was responsible for the proper sampling of the holes. Both departments were under the immediate supervision of F. H. Hayes, chief geologist. It was thought that, with the one man working for high footage and the other for reliable samples, the best results would be obtained. The arrangement worked well until toward the end of the

work, when it was deemed advisable to combine both departments into one. Under normal running conditions two 8-hr. shifts were worked at each rig per day. When for various reasons any one of the drills was shut down, the crews at that rig would be sent to work the third shift at some of the other machines. A crew consisted of a driller, a helper and a sampler. The driller with his helper had full charge of the machine while on shift and performed all operations in connection with its proper running. They cleaned the hole at 5-ft. intervals and dumped the cuttings into a launder, from which point the sampler took charge of them, as will be discussed further on. It was the sampler's duty also to assure himself of the exact ultimate depth of, and to ascertain the reliability of, each sample. In addition to this and to serve as a basis for compiling data on the work in general, he was required to keep a complete log of all operations performed during his shift and from this to make out a shift report.

To assist in the handling and hauling of supplies, tools and other heavy equipment, a teamster with a wagon and four horses was always in the field. An extra laborer was employed to help him and to perform other miscellaneous tasks. A Mexican packer with four burros kept the forges supplied with coke and the samplers' stoves with coal and brought all samples to the assayer.

This Method of Prospecting Well Suited to the Geology

With the exception of one quartzite rib, the rock is a sericitized quartz-monzonite porphyry, in which the primary minerals are disseminated chalcopyrite and pyrite mechanically mixed, and the economic mineral chalcocite. The ore occurs in the zone of secondary enrichment lying below a capping which is almost thoroughly leached and varies in depth from 0 to 350 ft. At the bottom of Fairbanks Gulch the capping is not so well defined, for there the sulphides were found right at the surface. However, as the top of Colorado Hill is approached, the leached zone increases in thickness, reaching a maximum of about 350 ft. at the summit. In general it may be said that the upper limit of the chalcocite zone in this region follows a curve somewhat less convex than the profile of the surface. An ideal section of a hole put down in the region would show at the top a leached zone in which the copper assayed from 0 to 0.25% and in which the iron occurred as hematite and limonite; then one or more zones into which the process of secondary enrichment had concentrated the copper to profitable percentages; and finally, at the bottom of the hole, the primary mineral, assaying about 0.3 to 0.4% copper.

An important feature, and one which has been closely observed in the field, is the degree to which the processes of silicification, kaolinization and sericitization have progressed, for upon these depends the strength of the walls in the mine to follow. In some places the rock has been so thoroughly altered that it readily caves and runs in, coming up in the bailer as thick clayey balls, tending to clog the riffles in the splitter. On the other hand, the ground has in many places been rendered very hard by silicification of the porphyry.

The depths at which ground water was encountered were carefully recorded for each hole, together with any important changes in its level after being struck. Like the upper limit of the chalcocite enrichment zone, the ground-water level was farthest from the surface below the summit of the hill and nearest the surface in Fairbanks Gulch. In most instances water was struck only after depths of at least 500 ft. had been reached.

In general the ground may be said to have been well adapted to the method of prospecting employed. Caving gave considerable trouble in only one section of the field—along the southern end—but this was effectively handled by the use of casing. Ribs of hard silicified porphyry occurring below regions of softer porphyry would frequently divert the tools from the vertical. Such contingencies were usually remedied, either by shooting the hole or by filling it up to the required depth with rock and cast iron and straightening it out by redrilling.

Five-Foot Samples Taken and Split to Eight-Pound Lots

As reliable sampling was the object, and as the deposit was irregular, 5-ft. samples were taken throughout the depth of the hole. As it was equally important to know the exact length and ultimate depth of a sample as to know its assay value, the hole was measured. This was called "checking in" and was done by laying off on the sand line the measured distance from the tops of the sand-reel flanges, up over the sand sheave down to the top of the platform as many times as possible, and then using a 5-ft. stick for the remainder. All measurements were made from the top of the platform, as this was to serve as the datum plane in all subsequent calculations. Depths were determined on the sand line due to its almost negligible stretch. The sampling equipment consisted in the main of a launder, a splitter, a drying stove and a desk.

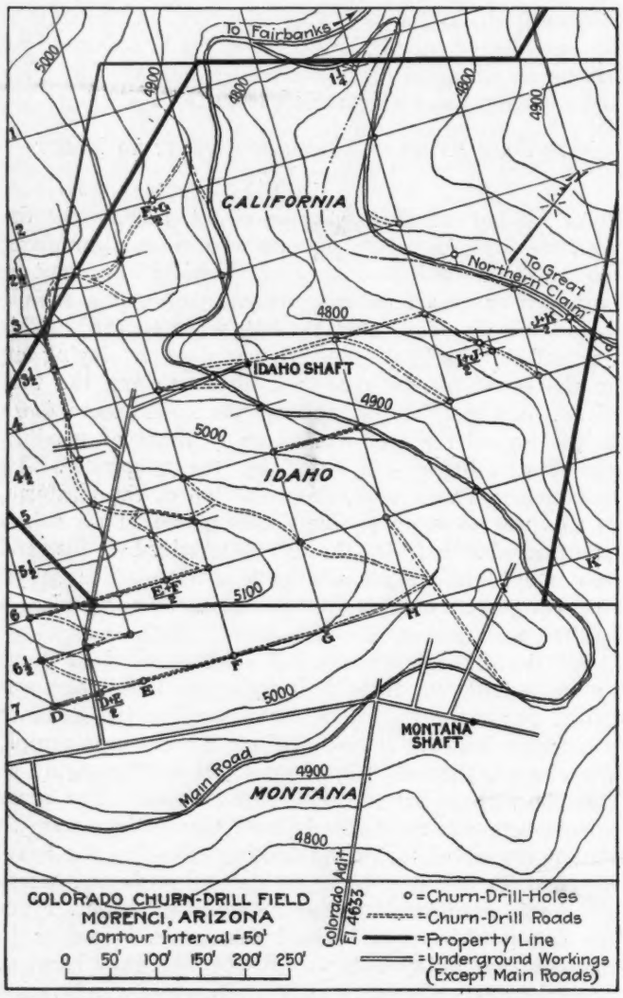
All the cuttings from a 5-ft. section went to make up the sample for those 5 ft., whether the sludge was bailed out more than once or not while the distance was being drilled. Before drilling for the next sample was started, the hole was cleaned out as thoroughly as possible with a dart-valve operated bailer. The error arising here was negligible because the cuttings were so thoroughly mixed up by the drilling tools that the heavier particles had practically no time to settle out before the sludge was brought to the surface in the bailer. From the bailer, which was lowered through a trap-door in the platform, the contents were discharged into a launder. These launders were built of 2x12-in. planks and varied in length from 10 to 18 ft. They were partly lined with iron plates of ⅛ in. thickness to facilitate cleaning, and the place where the bailers were dropped into them was still further protected by heavier plate. They usually rested below the platform in a ditch, with their head ends below the trap-door and projected out toward the downhill side of the station, with a slight pitch, to help carry the sludge to the splitter.

These splitters consisted simply of a series of Jones samplers[1] mounted on a framework in such a way that the tops of the riffles would be approximately horizontal when the frame was attached to the launder at an angle of about 45°. As the sludge passed through each set of riffles, it was split into two parts, one of which dropped to the ground as the reject and the other dis-

[1]Described in "Eng. and Min. Journ.," Aug. 21, 1915, p. 303.

charged upon a wide apron, which mixed it and conveyed it to the next set of riffles, and the process repeated.

The cuttings were passed through from four to six of these sets of riffles, depending upon the quantity of sludge, which in turn was determined by the size of hole drilled. The aliquot part of the whole remaining after the last split was collected in a metal pan, 12x 18x4 in., to one of the handles of which was attached a small brass check bearing the number of the rig and the depth of the sample. This was then placed upon a drying stove designed for the purpose, dried, placed in



LAYOUT OF CHURN DRILL FIELD AT MORENCI

a canvas sack, together with an assay ticket made out in duplicate and containing the numbers of the rig and of the hole, the depth at which taken, the date, a word as to its reliability, and the sampler's initials. The brass check previously referred to was tied to the bag on the outside for purposes of identification. This sample, weighing from 8 to 15 lb., constituted the assay sample and was sent to the assayer and its copper determined by the potassium-cyanide method. A small amount of each sample, ground down and ready for assay, was placed in a suitably marked envelope and stored away for possible future use, such as, for instance, the running of composites. The assay values were entered on the tickets that accompanied the sample in the sack. One of these was sent to the chief geologist's office and the other to the churn-drill office.

In addition to the assay sample, a certain amount of sludge was taken as a grab sample from the reject; this, after being washed free of mud and slime, was roughly examined by the samplers and briefly described on their shift report, then placed in a paper bag properly labeled and sent to the churn-drill office for examination with a hand lens and blow-pipe.

The sampler's stoves were constructed of small angles and $\frac{3}{16}$-in. iron plate, 8 ft. long, 2 ft. 6 in. wide, and stood about 3 ft. 6 in. high. At one end there was a firebox 2 ft. square, from which a flue ran back to the other end under the entire top and discharged into an 8-ft. stovepipe. Below this flue and running back from the firebox were two shelves, upon which wet samples could be dried under slower heat. When correctly fired, these stoves effectively handled as many samples as were normally taken in one shift. Care had always to be exercised not to overheat the samples and thus break down the sulphides.

The log was kept in ordinary engineering fieldbooks in the following manner:

LEFT SIDE					RIGHT SIDE
Hole G-6. Machine No. 1					Depth at beg. of shift. 480 ft.
Date 7/15/14. Shift 7:30 a.m.					Depth at end of shift.. 500 ft.
Driller, John Smith					
Helper, William Jones					Advance ..... 20 ft.
Sampler, H. Brown					Bits changed, 2
					Bits sharpened, 2
From	To	Time	Occupation	Depth	Any Remarks Regarding the Work
7:30	7:40	10	Cleaning out		
7:40	8:30	50	Drilling	475	4 splits, 1 bailing, 5 bailers
8:30	8:45	15	Bailing		(Description of sample)
8:45	9:00	15	Changing bits		

In the front of the book were placed some blank forms to be filled out, containing such information as the following:

1. Time of starting and finishing hole.
2. Depth at which change from spudding to drilling was made.
3. Depth at which drilling jars were first used.
4. Distance from top of platform (datum plane from which depths and elevations are figured) to actual collar of hole.
5. Depth at which ground water was first encountered and any important changes occurring in its level thereafter.
6. Amounts of drilling and sand line and casing on hand, supplied and used up.

The shift reports made out by the sampler contained the following:

1. Date, shift, machine, hole number.
2. Names of members of the crew.
3. Distribution of their time for the shift.
4. Footage made in drilling, cleaning out, reaming and underreaming.
5. Size and feet of casing lowered and pulled.
6. Details as to (1) how tools were working, (2) character of ground (that is, stability), and (3) groundwater level.
7. Description of the samples taken, under which were given (1) the depth, (2) name of rock (according to the sampler), (3) color of sludge, (4) minerals, and (5) quantity of sludge, number of times split, reliability and length of sample, and estimate of the copper content.
8. Further statements in regard to the shift's work.

These reports were brought to the churn-drill office by the samplers. Here they were entered on the records and then sent to the chief geologists's office for filing.

The importance of keeping complete records of the work was early recognized, and a comprehensive system was worked out and carried along with the work. These records are of two kinds; that is, for each hole there is a "Drilling Record" and a "Geological Record." Both have been kept on standard cross-section paper, which is well adapted to the purpose. Prints are readily made from this paper; while drilling and assay curves and geological sections are readily plotted to scale upon it.

The finished "Drilling Record" for any hole contains a complete history of the actual work performed at that hole from the time the previous hole was left. It consists of a sheet 48x22 in., upon which, beginnning at the left, are entered the date, shift, names of members of the crew, depth and advance made, level of the ground water, character of the ground in regard to hardness and stability, and the length of time consumed in drilling, cleaning out, reaming and underreaming. Under these last four headings various subheadings are given; for example, the operation of drilling is divided up into actual drilling time, bailing time and time for changing bits and stringing tools. Under the last three main headings—cleaning out, reaming and underreaming—are columns for depth and advance. Farther to the right is a section headed "casing," in which the size and number of feet of casing lowered, pulled or left in hole, time required for these operations, and also for preparing to case, are given. Next come columns for the following: "Tools hung up"; fishing jobs with the causes and results; repairs to machine, to cables or to sheds; and delays, such as waiting for power, tools, supplies and repair parts.

Then the number of samples taken and the time required for measuring in are noted, and following this are columns containing the time consumed in moving and rigging up to start a hole, one for general remarks and miscellaneous items, and finally, one for total hours worked during the shift. These columns are added up every month and on completion of the hole.

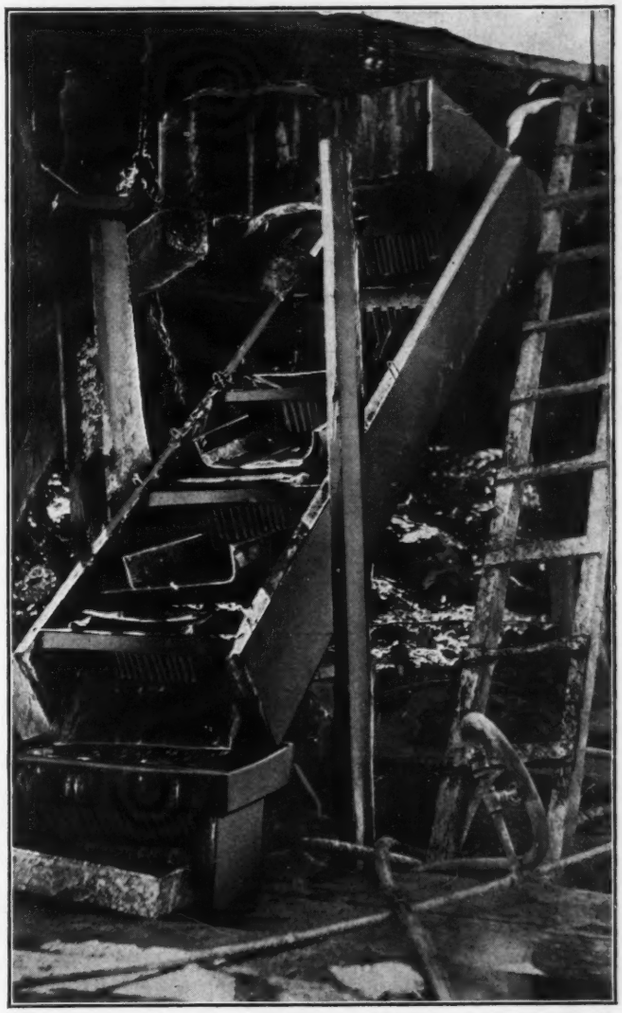
Some of Data Plotted in Curves

In addition to the foregoing, three curves are plotted on the right-hand side of the sheet, of which the first gives the average rate of drilling for each 5 ft. of depth. The purpose of the other two is to show how the average rate of drilling varied to date with respect to actual drilling time in the one and with respect to total operating time (exclusive of moving and rigging) in the other. The title gives the hole number, the machine number, the elevation of the collar and the date of starting and finishing.

On the basis of this data a monthly churn-drilling progress report was made out, showing for each rig and hole the footage made, total number of shifts worked, total actual drilling hours, together with the ratio of the latter to the total hours, number of samples taken, number of hours over the hole, also the average rate of drilling per shift, per hour of total operating time, per hour of total time exclusive of moving and rigging, and per hour of actual drilling time.

The "Geological Record" consists of a sheet 43x22 in., on the left of which are columns containing the date, depths of samples and assays, a statement as to reliability, color of sludge, nature of borings (regarding size and clay content), name of rock, rock and ore minerals, the order of predominance in the sample of the various constituent minerals and any remarks. An assay column and curve, together with average assays, a geological section and elevations of certain mine levels are plotted on the right-hand side and complete the sheet. These loose-leaf sheets, when bound together, will constitute a permanent record of drilling on Colorado Hill.

Small representative samples of the cuttings of each 5-ft. sample were placed in vials about 1½ in. deep and ⅝ in. diameter, bearing a label marked with the hole number, depth, copper assay and name of rock. The presence of copper in quantities over 2% is represented by filling the bottom to a depth of ½ in. with concentrates, and between 1.5% and 2%, with a quarter inch. These bottles placed end to end provide a record very similar to the core of a diamond drill.



AUTOMATIC SAMPLE SPLITTERS AND MIXING APRONS

The recording of data and the examination of the cuttings were taken care of by two men who had previously been samplers at the rigs. This work was done at the churn-drill office. In case of shutdowns at any of the machines, the samplers, as they worked on a salary basis, were detailed to the office for odd jobs.

During the year ended June 1, 1915, 51 holes representing a total of 37,025 ft. had been put down by the four machines and a total of 7,428 samples had been taken and the data filed.

The deepest hole was E-5, which went to a depth of 1,039 ft.; 11 holes went to depths ranging from 800 to 842 ft.; 13 averaged between 750 and 799 ft.; 12 from 700 to 740; and the rest were with a few exceptions put down to depths ranging from 500 to 700 ft. The average depth of all the holes on June 1, 1915, was 726 ft. The total number of shifts during which work was being done at the rigs was 2,248.7, from which the general figure of 44.1 working shifts for a 726-ft. hole may be derived. In connection with this, however, it must be borne in mind that on moving and casing jobs the day and night shifts worked together, and that this is counted as one shift. On this basis the average feet per shift for the entire period was very nearly 16.5. The record advance for one shift was 78 ft., but this was done while spudding. Footages varying from 50 to 77 for one shift were of common occurrence.

APPROXIMATE SEGREGATED COSTS PER FOOT TO JUNE 1, 1915

Drilling:	
Drilling	$0.387
Reaming	.009
Cleaning out	.006
Casing	.038
Fishing	.022
Moving	.098
Miscellaneous	.025
	$0.585
Supplies:	
Oil and grease	$0.004
Tools and new equipment	.114
Water	.035
Cables	.203
Casing	.073
Drilling	.002
Miscellaneous	.022
	$0.453
Tool Sharpening:	
Labor	$0.015
Supplies	.027
Power	.001
	$0.043
Power:	
Electric power	$0.110
Oil	.001
Labor	.052
Supplies	.033
Electric shop	.005
	$0.201
Repairs:	
Labor	$0.096
Supplies	.039
Machine-shop expense	.005
	$0.140
Sampling and Assaying:	
Labor	$0.297
Supplies	.062
Assaying	.037
	$0.396
Expense:	
Foreman	$0.060
Watchman	.006
Clerk	.015
Horse hire	.001
Telephone	.001
Electric lighting	.002
Power for pump (figure does not show in 3rd place)	...
Packing	.094
Road building (after Aug. 1, 1914)	.034
Station building (after Aug. 1, 1914)	.017
Sanitation, Bunkhouses, Fire insurance	Figures do not show in 3rd place of decimals ...
	$0.230
Total per foot	$2.048
Preparatory Expense, including	
Station and road building to Aug. 1, 1914	$0.416
Transporting rigs and equipment to field	.043
Building bunkhouses	.046
Main water line	.021
Telephone line	.004
Tools	.269
Installation of power units and lines	.174
	$0.973
Geology and Engineering, including models, estimation of quantities, mapping, locating holes, etc.	$0.018
Total cost per foot to date	$3,039
First cost of four drills and motors	.218
Total gross cost per foot	$3.257

Allowing 240 paid shifts per month to the four rigs under normal running conditions, 2,248.7 shifts represent 9.37 months during which all the machines were in actual operation. From this it follows that the average

APPROXIMATE PERCENTAGE COSTS TO JUNE 1, 1915

	Based on Cost of $2.048 per Ft.	Based on Cost of $3.257 per Ft.
Drilling	28.56	17.96
Supplies	22.12	13.91
Tool sharpening	2.10	1.32
Power	9.81	6.17
Repairs	6.84	4.30
Sampling and assaying	19.34	12.16
Expense (see above)	11.23	7.06
Preparatory expense	....	29.87
Geology and engineering	....	0.55
Four machines and motors	....	6.70
Total	100.00	100.00

footage per working month made by each rig for the year was 988 ft. The total number of actual drilling hours for the year was 9,772.5, giving an average of 3.79 ft. per hour. An interesting point is that the ratio to date of actual drilling hours to total operating hours is 54%, with a maximum of 58% during October, 1914, and a minimum of 50% during August, 1914.

The following summary shows the performance of each of the machines during the year ending June 1, 1915:

Drill No.	No. of Holes	Total Footage	Drill Shifts	Ft. per Shift	Total Cost	Cost per Ft.
1	13	9,814	626.09	15.68	$18,443.75	$1.879
2	14	10,781	654.97	16.46	19,764.86	1.833
3	13	8,628	478.82	18.02	14,271.10	1.654
4	11	7,802	488.82	15.96	13,208.67	1.693
Total	51	37,025	2,248.70	16.46	$65,688.38	$1.774
Stations and roads					171.47	
Casing					2,617.98	
Cables					7,382.21	
Total					$75,860.04	$2.048

Mine Patents and Extralateral Rights

By A. L. H. Street*

The conclusiveness of a patent to mineral land as evidence of title and the scope of extralateral rights were the two principal points passed upon by the United States Circuit Court of Appeals, Eighth Circuit, in the late case of Conkling Mining Co. vs. Silver King Coalition Mines Co., 230 Federal Reporter, 553.

It is held that such a patent is in the nature of a judgment which, in the absence of direct proceedings brought to cancel it, is conclusive as to the existence of all facts required by the law as a basis for issuing a patent, including location by the patentee upon the tract covered by the patent, filing of application, posting of notice, filing of certificate of improvements, etc. In other words, when no proceedings have been brought to annul the patent on the ground of fraud or error of law in its issuance, an adverse claimant of the land will not be permitted in collateral litigation, to offer evidence tending to show facts that would invalidate the patent.

The court reaffirms the rule that owner of a mining claim has no extra-lateral rights beyond his end lines extended vertically downward, except that when by mistake a locator places his claim across instead of along the vein or lode which he discovers, so that the latter crosses the side lines of his claim, his side lines become his end lines and he may follow the lode or vein on its dip beyond the vertical plane of the end line of his claim. "But," the court adds, "this is a special privilege, an exceptional right, and the burden was on the defendant to bring itself within the exception."

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Manufacture of Cartridge Brass*

By C. R. Barton†

SYNOPSIS—The manufacture of cartridge brass has so long been kept secret that those interested will welcome this article at a time when this commodity is in such demand. The drawing of cartridge cases is admittedly one of the severest tests of the quality of this material. The entire process of making cartridge brass—from the mixing to shearing the cast ingots—is given, together with the furnaces and tools, in detail.

The demand for cartridge brass during the past year has increased more rapidly than the means for its production. A number of firms not directly engaged in this class of work have installed equipment for making brass, in some instances building their own machines on account of the very long deliveries promised for nearly all classes of brass-working machinery. It is proposed to describe the methods and tools used in the production of finished bars of brass suitable for making blanks for cartridge cases. The author is not an experienced brass manufacturer, and concerning matters of technical details where practice may vary it is the intent to describe a proved method for turning out cartridge brass rather than completely outline the art of brass making.

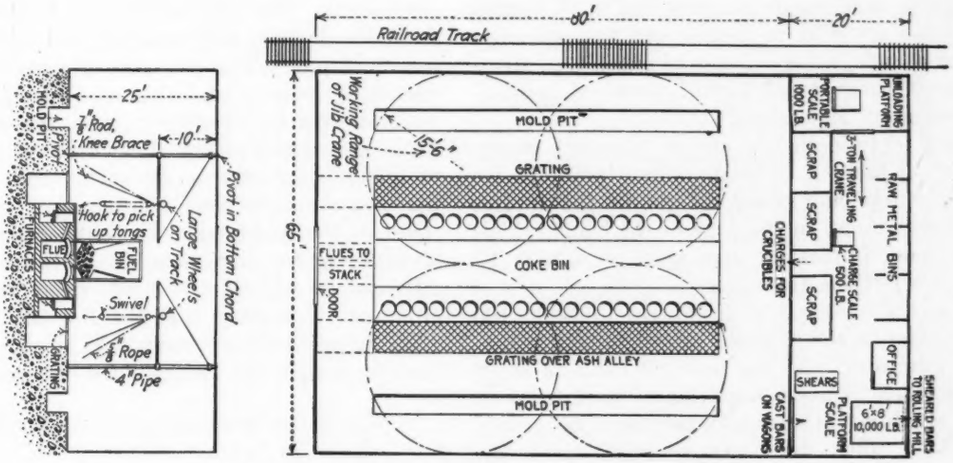

FIG. 1. PLAN AND SECTION OF CASTING SHOP

1. The specifications usually require either pure electrolytic or pure Lake copper and "Horsehead" spelter or its equivalent. Equally good results have been obtained using a spelter of not quite as high a grade as Horsehead. The maximum allowable impurities in good spelter should be: Lead, 0.30 per cent.; iron 0.04 per cent.; cadmium, 0.20 per cent.; and total, not over 0.25 per cent. In the copper the total impurities should not exceed 0.03 per cent. These are analyses which include all grades of copper and spelter suitable for cartridge brass and represent an average of materials supplied on recent orders.

2. A specification may be made covering the quality and maximum weight of scrap that may be used in the mixture for melting. This allowance runs from 50 to 65 per cent. of scrap brass, which may consist of scrap from the blanking press, overhauling machines and shears, the point being to eliminate foreign scrap, skimmings or scrap from the floor and mold pits, which may contain dirt and other impurities.

3. The right is reserved for inspectors for the purchaser to take samples and make chemical analysis of metals in stock, to check for conformity with specifications.

4. Chemical analysis of the finished metal ordinarily allows a variation of plus or minus 2 per cent. in the specified copper content, the proportions being usually 67 per cent. copper and 33 per cent. zinc up to 71 per cent. copper and 29 per cent. zinc. The total impurities permitted in the finished metal vary from 0.2 per cent. to 0.4 per cent., with the additional requirement that arsenic, antimony, phosphorus and cadmium must be kept within a minimum of from 0.04 to 0.08 per cent. In actual practice we have found that the foregoing limits of plus or minus 2 per cent. are fair and are about as good as may be secured with the average class of workmen. The average of 156 mill analyses running on metal 69 to 73 per cent. copper was 70.93 per cent., with six above 73 per cent. (the maximum being 78.6 per cent.) and seven below 69 per cent. (the minimum being 67.69 per cent.). In no analysis did the total impurities exceed 0.15 per cent., nor was there the least trace of arsenic, antimony or cadmium. There was a slight trace of phosphorus, which came from the phosphorized copper used as a flux.

5. Physical tests for finished metal are for breaking load and elongation. The requirements run from 40,000 to 44,000 lb. per sq.in. minimum breaking load, with a maximum sometimes specified between 48,000 and 50,000 lb. per sq.in. The minimum elongation required varies from 50 to 62 per cent.; but there is no standardized test piece used, so that these tests are not comparative. In addition, sometimes a formula for a combination of breaking load and elongation is specified, so that both minima may not occur at the same time. The pieces used for these tests are cut from blanks ready for ship-

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ment and have been annealed in the bar previous to being blanked. A cupping test is usually specified and is desirable, as it shows the temper of the metal and so checks its suitability for the first drawing operation without reannealing, as that is not absolutely determined by the elongation test previously described.

6. The variations permitted in dimensions of the finished blanks vary from plus or minus 0.005 in. to plus

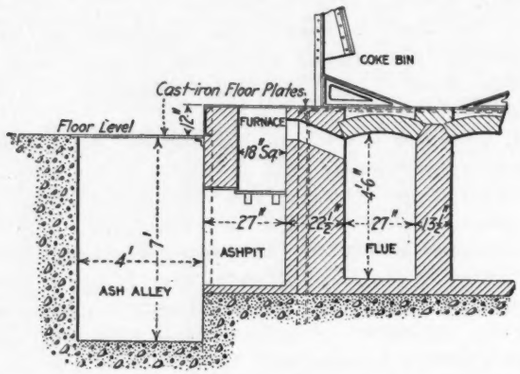


FIG. 2. TYPICAL SQUARE PIT CRUCIBLE FURNACE

or minus 0.015 in. in diameter. The allowance in thickness varies from plus or minus 0.003 in. to plus or minus 0.007 in. Where close limits are required, it is usually because the disks are sold by weight and the purchaser wishes to keep poundage down as low as possible, as otherwise the manufacturer would furnish disks of approximately the maximum dimensions.

7. The visual examination is one of the most important points of inspection. The disks are inspected for flaws, folding cracks and other defects in the surface and for pipes and cracks in the edge of the blank. This inspection is most important, and upon it usually 99 per cent. of all rejections are made.

8. Of the several methods of inspection probably 100 per cent. inspection is the best and fairest to both manufacturer and purchaser. As the metal is made in small lots at a time, there is not a condition of uniformity in manufacture which would warrant a partial or percentage inspection. Also, when the latter scheme is used, the inspectors require a lower proportion of rejected disks in the lot selected than the average on total inspection, so that usually it is necessary to return to total inspection.

9. Aside from the foregoing items various other clauses are inserted in the specifications by the purchaser's covering number of rehandlings allowed on rejected materials, size of lots submitted for inspection, microphotography and the manufacture of selected disks into cartridge cases for the development of interior flaws or defects not shown by visual examination.

As with all inspection where the most important point is visual examination, which is entirely dependent upon the judgment of the inspector, there is a possibility for considerable variation in opinion as to the extent and seriousness of defects. For this reason no hard and fast rule can be laid down as to what constitutes fair visual inspection. Where the inspection is done by a third party regularly engaged in inspection work, better results may be obtained than from inspection by the purchaser direct, whose judgment is based on personal opinions rather than experience as to the extent of defects that may be passed.

That division of the plant where the brass is melted and cast is usually termed the casting shop. This department covers all work from receipt and storage of copper and spelter up to the delivery of sheared bars to the rolling department. All the work may be carried on in one large room with suitable space partitioned off for a metal-storage and weighing room, hereafter called the scraproom. The usual construction is a steel-frame mill building about 25 ft. high to the bottom chord, so designed as to give maximum ventilation. The two main points to be considered in locating the casting shop are car sidings convenient for unloading metal for the scraproom and full and ample storage for fuel and ashes. As the sheared bars are handled on wagons, the location relative to the rolling mill is not so important as long as it is within a convenient distance for hauling.

Fig. 1 shows a floor plan of furnaces, ash alleys and mold pits for a typical installation. As the plant described was built for making cartridge brass in short bars, the pits are only 3 ft. 4 in. deep. In plants where the usual variety of rolled and drawn brass is handled, deeper pits, up to 10 ft. for casting bars up to 12 ft. long, are used. The unit of equipment is known as a set of fires, generally consisting of 10 furnaces and the necessary auxiliary equipment for the complete operation for casting bars. Each set of fires is handled by one caster and his helpers. The jib crane shown is for lifting the pots from the furnace and carrying them over the molds in the mold pits. The jib crane should be of such length that it can take in the extreme molds of each set of fires without greatly interfering with the adjoining set of fires. The space occupied by each set of fires is equal to that of 10 furnaces, the molds that can be filled by the output of the fires not taking a greater length of space in the mold pit. The size of the furnace is determined by the maximum size of the crucible used, the selection of which is covered under the discussion of crucibles. Assuming that the No. 90 crucible which is 13⅜ in. in diameter outside will be the largest size, and that we design our furnaces for coke as fuel, which re-

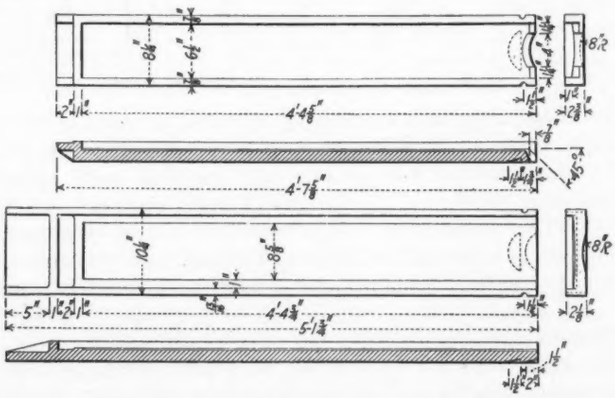


FIG. 3. MOLD FRONT AND BACK

quires the greatest space, say 5 in., and that the brick wall between each two furnaces must be not less than 13½ in., we have a maximum distance between centers of furnaces of 32 in.

Fig. 2 shows a larger-scale section of the furnace designed in accordance with these calculations. The furnaces are made square, as this style has a great advantage over the round furnaces in that the corners hold the fire

and permit placing the crucible tongs on the crucibles more easily. The furnace should be deep enough to provide at least 12 in. of fire beneath the bottom of the crucible, so that as the fire burns out on the grate the bottom of the crucible will not become cold. The depth should also be such that the top of the crucible is always below the bottom of the flue opening, in order to have all parts of the crucible subjected to an even heat. The furnace should be bricked up so that but one course of brick around the inside need be removed when the furnaces are relined, putting in only enough tie-bricks to the second course to hold the lining. The life of the lining varies greatly with the fuel used, coke making a much hotter fire than coal. Operating two shifts for four months made relining necessary on furnaces burning coke. The quality of firebrick and fuel must be considered as in other furnace work. The grate bars are 1 in. square, set on two bearers, such as a piece of 60-lb. rail. The draft may be natural or induced. A forced-draft system does not give satisfaction, as it rarely balances, thus throwing out into the room intense heat, which becomes a serious consideration in hot weather.

The ash alley should be of a cross-section that will allow easy passage of a wheelbarrow for removing the ashes when cleaning the fires. The coke bin, as shown, should provide storage for at least two days' requirements, and the monorail trolley is probably the simplest means for filling the bin from outside storage.

The quickest fire is not always the most desirable in the long run. Using a special 21-in. square furnace, we have been able to take out 21 heats in 24 hr., including cleaning fires twice. This is during cold weather; but it is doubtful if it is economical, as men cannot be secured readily who will stand up to such work, and the life of the crucible is greatly reduced. We believe 14 and possibly 15 heats per 24 hr. in winter a good production, falling off to 10 or 12 in warm weather. The men employed are not, as a rule, steady workmen, so that production is not a matter of simple arithmetic only.

There are other styles of furnaces, such as reverberatory furnaces, the Schwartz furnace and the type known as

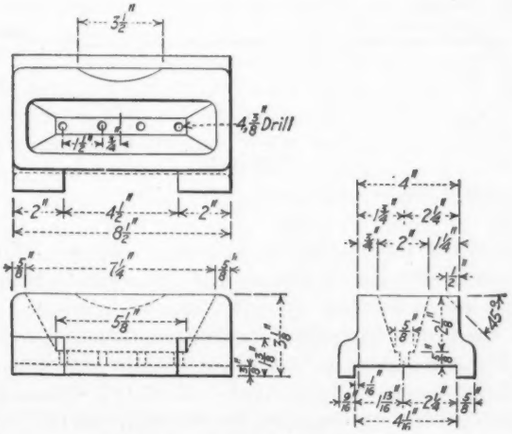


FIG. 4. MOLD STRAINER

the tilting furnace, in which the crucible is tilted for pouring. In all these a distributing ladle must be used, which means a second pouring of the metal. Repeated installations of the old-style crucible furnace, replacing some of the foregoing, show that for certain classes of work it is still the best in spite of the crucible expense.

Of late there has been considerable experimenting with various kinds of fuel. The plant here discussed is laid out for burning coke or coke and coal. Where maximum production is demanded, that method is most efficient which will enable the greatest number of heats to be obtained from one furnace in a given time. Hard coal

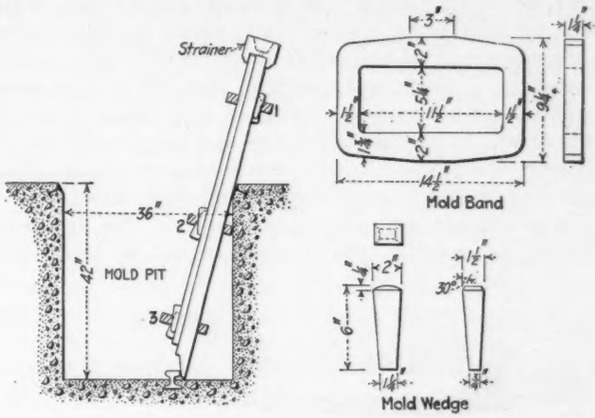


FIG. 5. MOLD BANDED FOR POURING

is probably the slowest fuel used, and the length of time required for getting out a heat is the only objection to it, as in other respects it is very satisfactory. Coke gives a much hotter and therefor faster fire, with a greatly increased wear on the furnace lining. Both oil and natural gas would seem to be desirable. The author has not had experience with oil-fired furnaces. Twenty of the furnaces shown in Fig. 1 were equipped for burning natural gas, using forced draft. Different methods for venting the furnaces were tried, but without great success. The heat from the furnaces was such that the cover brick became red hot and conditions were made intolerable for the workmen. We do not believe that the gas fuel was given a thorough trial, as it is no doubt the ideal fuel for crucible furnaces and will prove successful as soon as it has been put through an experimental stage in a large plant, where furnaces are necessarily set close together.

The fuel consumption varies with the rate of production and the size of the crucible furnace. No exact data can be given; the most reliable figures indicate from 0.4 to 0.6 lb. of coke and coal (mixed) per pound of metal melted during a period of several months, with 18-in. round and 21-in. square furnaces.

The molds for the cartridge brass may be seen in Fig. 3. They are made of gray iron containing 2.5 silicon and finished as shown. The size of the mold is determined by the width of bar required and the weight, which should be such that one pot of metal will make full-length bars. For convenience in handling, the bars are usually made from 80 to 125 lb., unless the size of the finished bar or sheet requires more metal. In rolling, the metal flows almost entirely in the direction of the rolls, so that if bars are passed through straight, there is no appreciable widening. Bars are cast in regular work up to 15 in. wide in short bars and up to 10 and 12 ft. long in narrow bars. It is always best to cast the bar of a thickness that will avoid as much rolling as possible, and the 7/8-in. thick bar is now about standard size, although 1¼-in. bars are made at times.

The molds should be planed on the joint. Otherwise, they will be strained in banding, as the wedges tend to

straighten out the molds, which rarely come exactly straight from the foundry, and thereby produce stresses that will soon crack either the front or the back of the mold. Also, with unplaned molds the leakage is many times that of the planed type. Another advantage is that the bars come clean and of even thickness. Some experiments with molds planed all over inside have been made by other firms in an effort to insure cast bars more uniformly good, but without favorable result. The molds shown are of very heavy section, but the weight may be cut down as soon as the most economical form is determined. In making rolled rods bars are cast 1½ in. in diameter and upward in solid bored cast-iron molds. The iron must be free from blow-holes and other flaws.

An important adjunct of the mold is the strainer, Fig. 4. In pouring, the strainer should be kept full, so that the slag and dirt passing the skimmer will not enter the mold.

The mold is held together, as illustrated in Fig. 5, by three bands wedged up tightly. The bands and wedges should be made of first-quality cast steel, if the use of expensive forged pieces is to be avoided. The order and manner of driving the wedge are shown by the numbers. This method has been found to reduce leakage.

The life of a mold is very uncertain. Some few foundries make a specialty of ingot molds, and their product has a high reputation. One of the largest brass makers in this country, after some years of experiment and experience, found that the molds of one firm gave uniformly 50 per cent. longer life than any other make. Molds should average at least 2,000 to 2,500 heats.

The several kinds of tongs may be seen in Fig. 6. All are made of wrought iron by the blacksmith shop in the plant. The most important are the crucible tongs for handling the crucibles. In forging, these tongs should be shaped to a cast-iron crucible of the same size as that to be used. Tongs should always be refitted whenever there is a change in either the make or the size of the crucible. Ill-fitting tongs injure the crucibles and may cause a loss many times the value of several sets of tongs. When worn and burned out of shape, the bits should be redressed or cut off and new ones welded to the reins.

Other tongs are spelter tongs for dipping the spelter in the molten copper, mold tongs for lifting the fronts and backs of molds, band tongs for handling the hot bands, stirring-rod tongs for holding the graphite stirring rods, and bar tongs for lifting the hot bars from the pit when the molds are stripped. These different kinds are illustrated in Fig. 6, and the weights, number required and other data are given in the table.

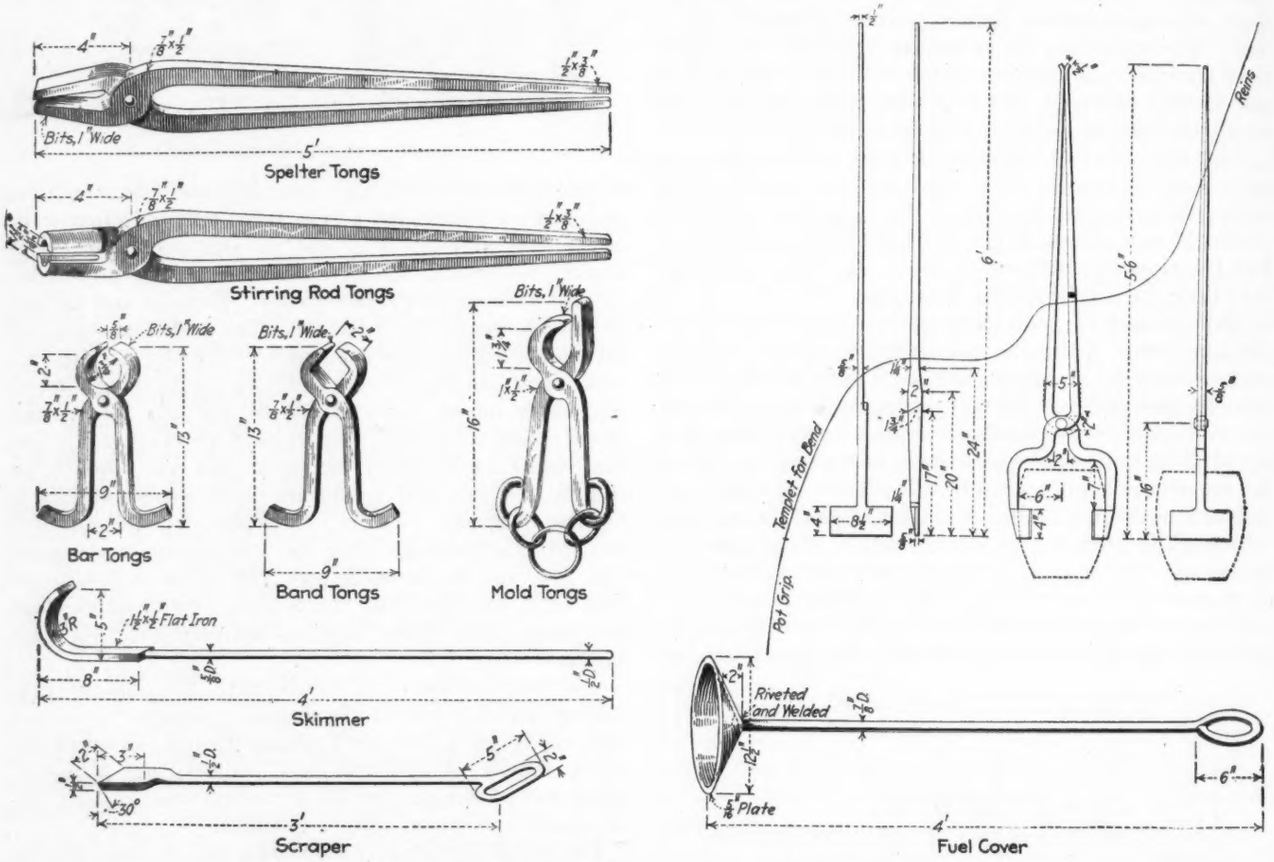


FIG. 6. A VARIETY OF TONGS USED FOR HANDLING THE WORK

The remaining equipment includes skimmers for skimming the pot when it is lifted from the fire and for holding back slag and charcoal that is not removed by skimming when pouring, scrapers for scraping the molds, wire brushes for cleaning molds after scraping, heavy buckets for mold dressing, powdered charcoal and flux, cheap 4-in. flat brushes for applying mold dressing, sledges, hammers, etc. Some of these tools may be seen in Fig. 6, and other data are given in the table. In most cases two sets of tools are allowed for each set of fires, as the tongs become too hot to be comfortably handled if used continuously.

In the table the probable life is given in heats. The author has not enough data at hand to give more authentic figures.

Crucibles are, aside from losses, the greatest single item in the cost of producing brass. For this reason many attempts have been made to get away from the use of crucibles. Long experience in crucible making shows that the best materials are Ceylon graphite and Klingenberg crown clay. Ceylon graphite is free from mica and is about 98 per cent. pure. The Klingenberg clay comes from a small district around the village of that name in Germany. These materials are blended and mixed in proper proportions, molded, dried and burned in a kiln. The amount of excess air in the kiln determines whether or not the graphite is burned out of the surface of the crucible, thus making the white or blue crucible. Obviously, the matter of color is of no importance, although manufacturers are called upon to supply crucibles of a given color. Crucibles usually contain from 50 to 60 per cent. of graphite.

Crucibles are known by number, each unit in the number representing nominally the capacity to hold 3 lb. of molten metal. Therefore, a No. 90 should hold 270 lb.

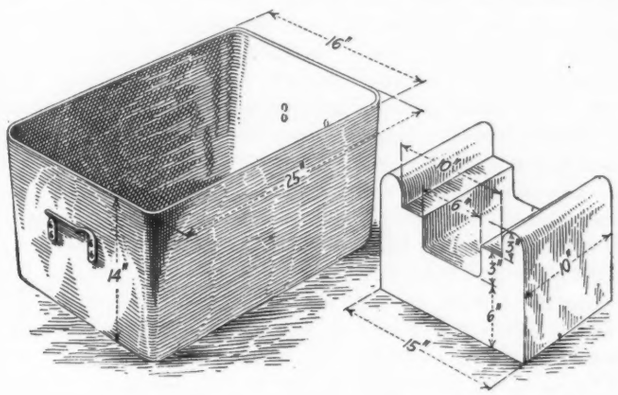


FIG. 7. TOTE BOX AND SPELTER-BREAKING BLOCK

of brass. About 80 to 90 per cent. of the capacity of the crucible may be used, depending on the care of the caster.

A year ago crucibles containing the best material sold for from 5 to 7c. per unit in the number. At the present time, owing to the high value of Ceylon graphite, the prices are 11 to 13c. per unit; and as the makers have only American clay to use, they expect only 8 to 10 heats per crucible. The average life of 1,500 crucibles purchased in July, 1915, was about 18 heats, so that the actual cost per heat has quadrupled. Manufacturers claim that their crucibles average 25 heats, and doubtless this figure may be attained with the best materials.

The life of a crucible is shortened by ill-fitting tongs, as previously stated, by excess fluxes of various kinds, by soaking in the fire longer than necessary to melt the metal, by too high furnace temperatures in the endeavor to get quick heats, by wet or sulphurous fuels that attack the outside of the crucible, by carelessness in stirring the metal and by general lack of care in handling.

In the employment of fluxes such as fluorspar and various silicates a mean must be determined so that the metal will be purified with a minimum erosion of the crucible. The crucibles should be thoroughly dried and annealed for two of three weeks before being put into service. This is frequently done by storing them on a floor on top of the muffle furnaces used for annealing in the rolling mill. A careful record of the size and number of crucibles given to the casters should be kept.

The best size of crucible has been found by long practice to be the No. 80, holding a charge of 200 to 220 lb. of brass. This crucible makes two bars of convenient size in narrow metal or one in wide metal. It seems to have a somewhat longer life than larger crucibles and therefore, striking a mean between labor and crucible expense, gives the lowest cost of production. There is much juggling of sizes, and many makers rate their crucibles above standard, so that buyers should compare cubic contents and weights rather than size numbers.

There are several compounds on the market for applying to the crucible as a paint. Some report these materials to be of value. Broken crucibles should be placed in bins, and in spare time, laborers may be set to work chipping off the inside surface, which may have some metal adhering to it. The latter is reclaimed with the ashes. The old crucible material commands a market price of from $10 to $15 per ton.

Probably no subject in brass making has received as much attention as fluxes. And when all has been said, brass makers are still employing the same fluxes with or without their potent secret additions. For clean scrap and new metals such as must be provided in making cartridge brass, phosphorus and common salt seem to give the best results. The phosphorus is in the form of 15 per cent. phosphorized copper, 1 oz. per 100 lb. of metal. A larger quantity may be used if needed, but not enough to give a perceptible amount of phosphorus in the finished metal. Common salt, somewhat finer than crude rock salt, should be added, about one handful per 100 lb. of metal. Care should be taken to avoid an excess, as this attacks the crucible.

The impurities to be removed are mainly copper oxide, sand and dirt. The foreign metals—tin, iron and lead—cannot be removed, and none should be introduced by iron stirring rods, brass scrap containing lead, etc. The copper oxide forms readily, and for this reason the melting metals should be covered with powdered charcoal to prevent oxidation. Patent fluxes are generally in the identical class with medicines of the same description.

The metal-storage room, also known as the scraproom and weighing room, is one of the most important parts of the brass-manufacturing plant. Here the new metals are received and stored, all scrap is received and weighed, and the charges for each heat are weighed up in correct proportions. The plan, Fig. 1, gives the arrangement at the plant described. The room contains bins for the various grades of scrap, keeping clean metal, floor scrap and the recovered metal apart; space for storing bars of copper and spelter; a four-bar scale for weighing the charges; a platform scale for weighing metals received and the cast bars on wagons before and after shearing; and a powerful lever shear for cutting new metal and cast bars. As the records of this work are very important, a small office should be provided so that the foreman may keep his records neatly and accurately. The scales for weighing the charges are set by the chemist and should be kept under lock. The charges are weighed up in small iron pans illustrated in Fig. 7.

The cast bars are brought in in a wagon and weighed on the platform scales. The heads or gates of the bars

are then cut off in the shears and the bar cropped back until the cross-section shows good metal without pipes or other defects. It is important that a skilled man of excellent judgment have charge of the shears, as much good metal may be cut off as scrap if the bar is cut back too far. Likewise, a large amount of work is wasted and the percentage of scrap in the finished product increased if the bar is not cut back far enough. The color of the sheared section will indicate relatively small variations in the copper and zinc content, so that the experienced shearman will recognize bars that are outside the specified limits and cut them up. A bar that is cut to much less than half its length should be cut up, as it is probable that it has objectionable defects not visible. It also gives trouble in handling and rolling. The shears should be powerful enough to cut brass 1½x10 in. They will then be able to cut up copper ingots in suitable sizes for weighing out exactly on the charging scales. A small breaking block for spelter is also shown in Fig. 7. After the bars are sheared, they are weighed, and the caster is credited with the weight of good metal thus produced. The floor scrap—from broken pots and leakage from the mold pits—is collected once each day and weighed into the storage bin in the scraproom.

The charges weighed up in the scraproom are brought out on the casting floor and set behind each furnace, accurate record being kept of the number of boxes given each caster. The first operation, starting each day's work, is to clean the fires by pulling out the grate bars and removing the ashes, care being taken to punch out the clinker that has formed at the bottom, as this sometimes reduces the cross-section of the grate to one-third its actual size. A fresh fire is then built, which in continuous operation is usually lighted by the hot bricks in the furnace. As the fire comes up to heat, the crucible, which has been previously warmed by being on top of the furnace, is placed in the fire, and the heavier metal of the charge, except spelter, is laid carefully in the crucible, care being taken that the metal does not tend to wedge the pot apart during melting, when the pot becomes soft. Ordinarily, a ring made from the upper half of an old crucible is placed on top of the crucible to hold the scrap and copper that cannot be put inside.

TABLE OF EQUIPMENT FOR ONE SET OF TEN FURNACES*

Name of Article	Number Required	Life in Heats, Each	Weight, Lb., Each	Cost, Each
Crucible tongs	2	7,000	55	$6.00
Spelter tongs	2	800	12	1.25
Stirring-rod tongs	2	2,500	13	1.25
Band tongs	1	Indefinite	6	....
Mold tongs	1	Indefinite	9	....
Bar tongs	2	7,000	6	....
Skimmer	1	35	5	....
Scrapers	3	Indefinite	4	....
Punch bars, 7 ft. of 1-in. round iron	3	....	..	....
Chisel, ⅞-in. hexagon flat, 14 in. long	1	....	..	....
Files, 18-in. bastard-cut mill	2	....	..	....
Hammers, 6-lb. crosspeen blacksmiths', 12 - in. handle	3	....	..	....
Fuel cover	1	Indefinite	20	....
Wire brushes	3	10,000	..	.20
Charcoal box, wooden, 4x4x3 ft.	1	....	..	....
Oil pail, heavy 2-qt. bucket	1	....	..	....
Oil brushes, 4-in. flat paint	2	....	..	....
Salt pail, heavy 4-qt. bucket	1	....	..	....
				Per Lb.
Molds	20	2,000	450	.05
Bands	60	200	25	.05
Wedges	100	3,000	5	.03
Strainers	20	Indefinite	27	.03

*The figures are approximate, as in some instances they are based on estimate only.

In this case the scrap should be put in the bottom, as it melts faster than the copper.

After all the metal is melted and up to a bright heat, the spelter, which has been warmed by lying on the furnace, is thrust beneath the surface of the metal and is rapidly melted and alloyed with the copper. The brass is then stirred thoroughly with a graphite stirring rod, so as to secure a homogeneous mixture. The graphite stirring rods are expensive, but are the best for high-grade brass, as iron from an iron stirring rod will alloy with the brass and thus increase the impurities. During the melting, salt and powdered charcoal are thrown on the metal, the charcoal to protect the molten metal from the atmosphere and the salt to act as a flux. After a vigorous stirring, the metal is given a minute or two to allow the impurities and dirt to come to the surface in the form of slag. The crucible tongs are then placed on the crucible, which is raised from the furnace by means of the jib crane. The outside surface of the crucible is cleaned, and it is then lowered on clean sand on the floor. The slag is skimmed off and a block of wood thrown on the clean surface of the metal.

The point might be made that there is the same objection to the iron skimmer as to the iron stirring rod. Actually, the amount of iron absorbed in skimming is much less, and graphite is less suited to the rougher handling. The crucible is then raised and placed over the strainer on the mold and poured, tipping the crucible forward with the tongs, keeping back the residue of slag and charcoal with the skimmer.

The block of wood in burning tends to keep the air away from the metal and is useful in reducing the amount of spelter burned out. The strainer should be kept full of metal so that the slag and dirt passing the skimmer remain on the surface and do not enter the mold. The molds should not stand slanting sidewise, as there is a possibility that impurities and gas pockets will lodge in the corner of the mold instead of coming to the surface, so that one edge of the bar may be defective for the entire length of the mold.

The molds are prepared by scraping with the scraper and brushing down thoroughly with a wire brush, after which they are painted with lard oil. Many substitutes are offered as a mold dressing, but lard oil seems to secure the best results. The molds are then banded and wedged up tight and are ready for use, the strainer being placed on top. After pouring, the metal is soon chilled sufficiently to allow the bands to be knocked off and the mold opened. The bars are raised with the bar tongs, and the burrs are filed off. Then the bars are piled on the floor behind the mold pit and allowed to cool until they can be loaded on wagons and taken to the shears in the scraproom. The molds are cleaned thoroughly and dressed with lard oil each time before being used.

The term "losses" covers the difference between the metal weighed out and melted and the total metal returned. The gross loss includes the metal in the ashes, and the net loss is that determined after the ashes have been put through the recovery plant and a large part of the metal in the ashes reclaimed. The net loss is therefore the difference between metal melted and that returned from all sources.

The melting loss varies with the type of furnace used, size of charge and proportions of mixture. On cartridge brass under the conditions outlined the gross loss varies

from 3 to 5 per cent. No figures are available for the net loss, but in other plants it varies from 1 to 3 per cent.

The loss represents a greater money value than the profit in manufacture and therefore should be given the most careful attention. An installation and working conditions which prevent metal from being lost in the fire by careless charging and by the use of worn-out crucibles and which avoid excessive volatilization of spelter by not using enough charcoal to cover the molten metal, by not overheating the metal, by pouring as soon as ready and not soaking the metal, by not using unnecessary draft, etc., will go far toward reducing this expense.

Metal spilled in handling and pouring is recovered from the mold pits and floor each day. This is known as floor scrap, and to it is added the solid metal picked from the skimmings and ashes, which contain the metal representing the difference between the gross and the net losses. No figures are available to give proportion by weight of recoverable metal in the ashes in the plant described, but it has been found by other firms to run from 0.25 to 0.50 per cent. by weight of ashes.

This recovery is made by concentrating and refining processes. The quantity of ashes is not sufficient to warrant a recovery installation in any but a large plant. The floor scrap may be melted directly with the charge in small quantities or remelted and sheared before using, as the quality of work may require. Some specifications for cartridge brass permit the use of floor scrap; and if used judiciously, no bad effects will be noticed.

In addition to the tools and equipment mentioned the following materials are required in the approximate quantities given, which are the results of several months' operation:

Coke	50 lb. per 100 lb. metal melted
Charcoal (used in lighting fires)	0.1 bu. per 100 lb. metal melted
Lard oil No. 2	0.04 gal. per 100 lb. metal melted
Salt	0.25 lb. per 100 lb. metal melted
Phosphorized copper	1 oz. per 100 lb. metal melted
Graphite stirring rods, 1½x 18 in. long	30 heats each

For a plant having 40 furnaces, or four sets of fires, there will be required 4 casters, 16 to 20 casters' helpers and 4 laborers. These men will be able to produce from 5 to 7 heats from each furnace in about 9 hr. The casters are paid on a tonnage basis at the rate of 17 to 20c. per 100 lb. of good sheared metal. The casters pay two helpers at 65c. per round, which is one heat from each of the two furnaces comprising a set of fires. The firm supplies additional helpers at the same rate, giving three men if special circumstances require them. A better arrangement is to pay on a tonnage basis for the entire crew about as follows, per 100 lb.: Caster, 8c.; floor helpers, 5½c.; pit, 4½c.

In this scheme the bars are marked with the crew number, and a deduction is made for bars scrapped at the overhauling machines in the rolling mill, as metal apparently good at the shears may be poor metal when overhauled—that is, the process of scraping off the surface metal, dirt, etc., preparatory to rolling.

The scraproom requires about 10 men—4 on the shears and 6 on the scales. The pay of these men runs from 20 to 30c. per hr.

The direct cost for producing sheared bars ready for rolling is about ½c. per lb. of metal melted, divided about evenly among labor, supplies, renewals, etc. To this figure must be added the value of metals lost and burden. These items may vary greatly. The distribution of metals between weighed charge and sheared bars is as follows:

	Per Cent.
Metal weighed out	100.00
Net loss, volatilization, etc.	2.50
Recovered metal, ashes	2.00
Floor scrap	5.00
Shear scrap	10.00
Good sheared bars	80.50

These figures represent what may be called fair to good operation, but undoubtedly offer opportunities for further economies. The importance of accurate records will be appreciated in making an estimate. Several of the most necessary are shown.

To many it might seem that the crucible-furnace method of making brass is antiquated and that units of larger capacity should be used. But segregation, gas occlusion, rehandling and consequent cooling in ladles and higher losses are still disadvantages of the large furnace that must be taken into consideration.

For rolling, the metal must be homogeneous and absolutely free from dirt. Therefore, metal molds are preferred, and the consequent chilling allows no time for impurities to rise to the top. Also, the chemical analysis must be fairly close; and as one component of the alloy is easily oxidized, the metal must be melted, poured and cooled quickly. No doubt many improvements will be introduced into brass making in the immediate future, as experimental investigation is now being taken up in earnest by many manufacturers.

Breach of Mining Contract

By A. L. H. Street*

A contract for sale of a mine, under agreement that a portion of the purchase price should be paid out of the proceeds of development, bound the purchaser to install machinery and keep the mill in operation, under penalty of forfeiture of the contract on abandonment of work for six months.

Interpreting this agreement, the California Supreme Court holds that it required the development work to begin promptly after the purchaser took possession of the property, and not merely after the machinery was installed; and that, in any event, failure for six months to install the machinery entitled the seller to forfeit the contract. (Barandun vs. Barandun Mining and Milling Co., 156 Pacific Reporter, 473.)

Interstate-Callahan

Report of the Consolidated Interstate-Callahan Mining Co., Wallace, Idaho, for the first quarter of 1916 shows total net value of shipments and miscellaneous receipts of $1,030,440. Operating costs were $207,117, leaving profit of $823,323. Total tonnage mined was 29,897 tons; shipping ore, 17,132 tons; a ratio of 1.84 to 1. Concentrates produced were 903 tons of lead concentrates and 12,972 tons of zinc concentrates. The lead concentrates assayed 19.89 oz. Ag and 50.4% Pb, and the zinc concentrates assayed 49.12% Zn. The recovery of zinc in concentrates was 88%. Cost of mining was $4.48 per ton; of milling, $1.46, and of shipping, $0.533 per ton—a total cost of $7.06 per ton treated.

*Attorney at law, 829 Security Building, Minneapolis, Minn.

Details of Practical Mining

Adit Enlargement and Alignment at the Alaska Juneau

By John Richards*

The cutting of the drainage ditch in the Gold Creek tunnel, the 6,500-ft. working adit into the Alaska Juneau mine, was postponed until the tunnel was completed. The ditch when started was 1½x1½ ft. and ran along the left-hand side of the tunnel. This work was started

JACKHAMER USED IN TRIMMING UP THE TUNNEL

in July, 1914, with all drilling being done by hand. The difficulty with the ordinary machines working on a column or bar, in this work, was that the tunnel had to be kept open for haulage at all times. This prevented the use of a rigid set-up as the train might come at any time and necessitate the removal of the bar. After two months of hand drilling, however, the Ingersoll-Rand jackhamers were started on the work. The size of the ditch was increased to 2x2 ft. at the time the jackhamers were introduced. The accompanying table shows the cost of the work by months.

1914	Hand Drilling; July and August	Jackhamers Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Feet driven...	514	396	431	815	1,287	1,018	810	1,044
Labor cost per foot	$1.36	$0.91	$0.49	$0.30	$0.38	$0.37	$0.46	$0.38
Explosives cost per foot.....	.21	.27	.27	.27	.28	.28	.29	.27
Total cost per foot...	$1.57	$1.18	$0.76	$0.57	$0.66	$0.65	$0.75	$0.65

The above figures summarize to the following: Average cost of labor per foot when hand drilling was $1.36, when using jackhamers, only $0.42. The data on running times and footage drilled were not obtained due to the intermittent character of the work. Drilling and mucking was done by the same crew and it was necessary to so arrange the work that the train service would not be interrupted.

In conjunction with digging the ditch, the tunnel, originally of 7x9-ft. cross-section, was straightened and widened to a minimum of 8 ft. In many places the roof was low and this too was taken down. The drilling for this work was done by the jackhamers, the depth of holes drilled varying from 1 to 7 ft. In taking down the roof, a portable mounting, designed in the Alaska Juneau shops, was used to hold the machine in place. This mounting, shown in the accompanying illustration, consists of a short length of 1-in. pipe terminating at its upper end in a small fork which fits around the cylinder of the drill, and its lower end, sliding inside a 1¼-in. pipe with a collar and set screw at its upper end which make possible the adjustment of the fork at any height. At the lower end of the larger pipe, which is about 4½ ft. long, is a larger fork, spreading about 16 in. at the lower points. This fork rests on the ground and gives the whole mounting stability.

When using this mounting in drilling the lower fork is placed slightly forward, giving the mounting a backward slant when starting the hole. As the hole deepens, the mounting becomes vertical and then is inclined to the front. From time to time the upper fork is raised and adjusted by the set screw in order to keep the machine in line.

The chief advantage of the jackhamer in this work was its portability and its ability to drill while so close to the wall or roof, requiring a minimum inclination for the hole and hence a minimum amount of rock broken for the gain made in height or width, and allowing also, longer holes to be drilled.

*Superintendent, Alaska Juneau Gold Mining Co., Juneau, Alaska.

Mine-Car Wheels

Complaints are being made by mine operators concerning the types of mine-car wheels. Such wheels have always been made similar to those of the railroads, in regard to the depth of the flanges, says C. W. Crawford, in *Coal Age*. However, the mine tracks are not laid with the same accuracy and permanence as those of the railroads, and in consequence the cars frequently jump the track, with inconvenient results.

It is suggested that the flanges should be made deeper to insure a safer grip on the rails. The wheelbase of mine cars is necessarily short in order to pass the short curves, and this admits of more or less rocking motion, which, together with unevenness of track, causes the wheels to

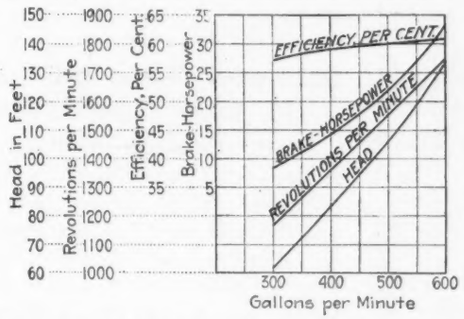
rise above the rails, at times sufficiently to allow the flange to pass over. Therefore it is reasoned that the flanges ought to be enough deeper to prevent such jumping. The usual depth of the flanges is about 1⅛ in., sometimes less. It is believed they ought to be 1½ or 1⅝ in.

Centrifugal Pump for Variable Delivery*

In draining mine workings in comparatively flat viens, one of the most common conditions is that of pumping an amount of water, which varies widely with the seasons, against a low static head, through a long discharge line.

In such a case the increase of head due to the resisting friction of the interior surface of the pipe may become great, so that the static head is only a small percentage of the total resistance against the pump. The head due to friction in a pipe increases nearly as the square of the velocity, and for a long discharge line with relatively small static head, the total head will vary in approximately the same ratio.

The delivery of a centrifugal pump increases directly as the speed, while the head developed increases as the square of the speed. Also, when the speed of a properly designed centrifugal pump is changed from the normal,



CURVES OF EFFICIENCY, HORSEPOWER, SPEED AND HEAD AGAINST WHICH PUMP OPERATES

the efficiency changes but slightly at first, so that a variation of speed of 30% higher or lower is possible, without greatly decreasing the efficiency from its maximum.

It thus appears that a centrifugal pump with adjustable-speed drive is most admirably adapted to meet the condition mentioned; that is, a variable delivery against a discharge head consisting principally of frictional resistance. Under the conditions named, the pump will show a good and nearly constant efficiency at all speeds and deliveries; and owing to the relation between velocity of flow and frictional resistance in the pipe, reduction of the delivery to one-half will reduce the power requirement to approximately one-fourth the maximum.

It is readily seen that when, owing to seasonal or other conditions, the amount of water to be handled is considerably less than the maximum, the adjustable-speed centrifugal pump is of great value, giving much better power economy than any constant-speed pump arranged to handle the maximum discharge.

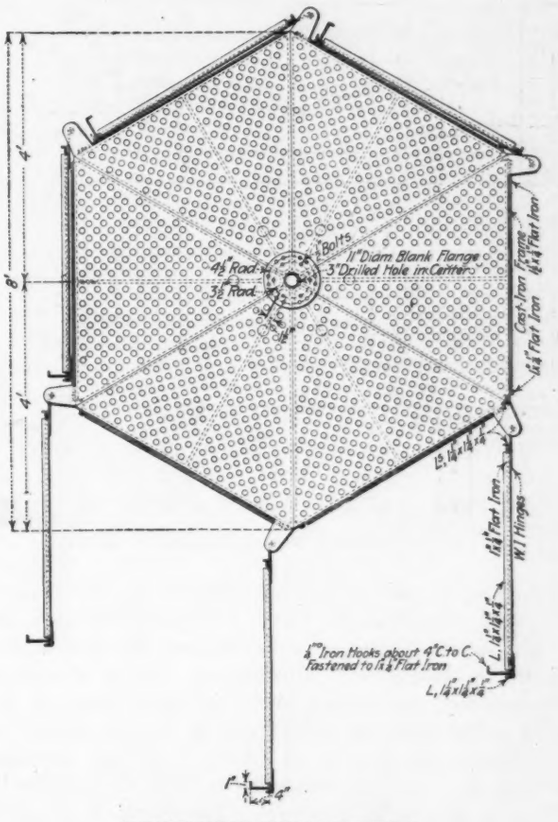
Power available underground for driving a centrifugal pump will generally be in the form of direct current. The shunt-wound motor, with speed adjustment by shunt field control, shows good efficiency at all speeds within its range; and when direct-connected to a properly designed centrifugal pump operating under the conditions previously outlined, a unit results having good efficiency over a wide range of delivery.

To illustrate the foregoing, curves are given herewith, showing the characteristics of a 4-in. single-stage, double-suction centrifugal pump, direct-connected to a 40-hp. shunt-wound motor having a speed adjustment from 1,165 to 1,750 r.p.m. and a delivery at its maximum speed of 600 gal. per min. against a 30-ft. static head, through 850 ft. of 5-in. wood pipe.

An inspection of these curves shows that at 1,750 r.p.m. and a discharge of 600 gal. per min., the power requirement is 33.2 hp. and the efficiency 61%. At 1,165 r.p.m. the discharge is 300 gal. per min., the power requirement is 8.2 hp. and the efficiency 57%. A regular gradation exists between these extremes.

Kelp Screen for Pacific Coast Pumping Plants

Salt-water pumping plants on the Pacific Coast experience a great deal of trouble, at certain seasons of the year, on account of the enormous quantities of kelp drawn



REVOLVING KELP SCREEN

into the suction pit or pipe. The Chuquicamata is building a long trestle to carry its suction far out from shore in an endeavor to alleviate this trouble. At El Segundo refinery of the Standard Oil Co., near Redondo, Calif., an ingenious and effective screen has been devised, according to *Power*, May 23, 1916, to solve this problem.

A six-sided revolving screen rack, shown in the accompanying illustration, extends across the pit. Screens 4x6

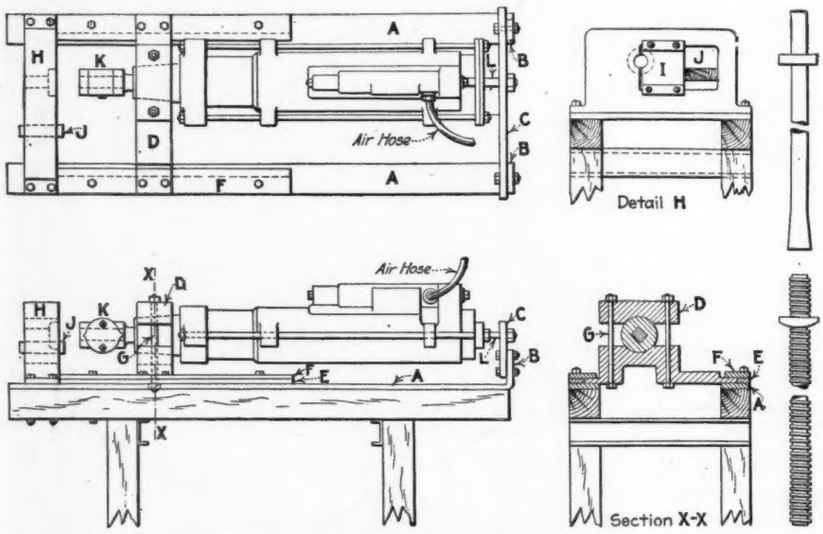
*A. N. Cole, in "Coal Age," May 20, 1916.

ft. are hinged along one edge to the rack. The screens on the under side of the roll hang vertically, and the bottom one seats against an angle iron embedded in the concrete of the pit floor. The pump suctions are in the rear of this angle iron, and the current draws the kelp against the screen, where it is caught by a number of prongs. When the screen becomes covered with kelp to a degree that interferes with operation, the rack is rotated, permitting a fresh screen to seat on the angle iron, and raising the kelp-covered one above the water surface, where the kelp is removed by forks and rakes. A hand-power crane spanning the pit is used to rotate the rack when it is too heavily loaded to move with pry bars.

A Steel-Collaring Machine

By C. Carlton Semple*

At the Tonopah-Belmont mine at Tonopah, Nev., the collars on the shanks of hollow drill steels for the water Leyner drills are upset by a pneumatic-hammer machine improvised out of an A-8 Waugh hammer drill, by Mr. Hendricks, the master mechanic. The device is also used to upset the collars on the tool-steel stock in making the feed screws for air drills. A much stronger job is done by upsetting than by welding separate pieces on, since in the latter case failure usually results at the weld soon after the piece is subjected to hard usage.



DEVICE FOR COLLARING MACHINE STEEL

The device is extremely simple and effective, as shown in the accompanying illustration. On a strong table are mounted two pieces of 5x1-in. steel bent, as shown at *A*. The ends are turned up at *B*, and across them is bolted a heavy plate *C*. An A-8 Waugh air-hammer drill is securely held between the plate *C* and the block *D*, in a horizontal position. The block *D* is movable and held in place by the plates *E* and *F* and secured by the bolts *G* so that the distance between *D* and the die holder *H* can be adjusted, but held firmly at the required distance once the adjustment has been made. A die holder, or anvil, *H* is secured at the end of the table, the general design of this piece being shown in detail in the sketch. The dies for this block are made in halves, one of which fits in the recess of the right-hand side of the block, while the other half of the die is held in the movable piece *I*, which is forced against the other piece by the key *J*. One-piece dies to suit the work to be done are inserted in the chuck *K* of the drill.

In adjusting the device to the desired distance between *D* and *H*, a short piece of angle-iron is slipped over the feed bar *L*, holding the desired spacing by bearing against the end of the drill and the plate *C*.

The required adjusting having been made, the key *J* is removed and the movable die block *I* moved over so that the stock, heated at the point where the collar is to be formed, can be inserted between the two parts of the die, the short end of the piece on which the collar is to be formed passing into and being held by the one-piece die in the drill chuck. The movable die block *I* is brought up close on the stock and driven home by tapping on the key. Air is then turned on and the collar upset.

In making the collars on the larger drill feed screws, two heats are necessary to finish the job; a heavier drill would be better for such work. Nevertheless 70 such feed screws have been made on this machine in one day, where formerly 6 had been considered a good shift's work. The work done by this machine in making collars on the shanks of water Leyner drills and on feed screws is shown by the sketches at the right of the accompanying illustration.

*Mining engineer, Stamford, Conn.

Miners' Use of Cedar in the Northwest

In the Canadian Northwest sound cedar trunks are found up to 3 ft. diameter. These are of course dead and dry and have few branches. Miners doing assessment work or prospecting find them a source of great assistance. A clear tree is selected near the camp site and sawed down and into pieces about 10 ft. long. With broadaxes and wedges these are split readily into slabs. These slabs are prismatic in shape. A little deft trimming with the broadax reduces this to a more or less even board. A framework—built of heavy slabs and sheeting of thinner ones forms the sides, roofs and floors. One of these cabins may be made in two days by a man and his "pardner" and is weatherproof throughout the severest winter.

Chunks sawed from cedar logs are split with great ease. In an hour's time one chunk can be sawed off and split into firewood sufficient for 3 days' use. Cedar in the Northwest is known as the miner's friend.

With a View to Preventing the Spread of Fires which may obtain too strong a hold on square-set stopes to permit extinction without flooding the workings, the Broken Hill Proprietary Co., New South Wales, forms in various places in the workings, barriers to the progress of fires by having all timber connecting adjoining sets replaced with iron or steel spreaders, generally railway rails. If these barriers are constructed while ordinary stoping proceeds, very little added expense is incurred, as there is generally a stock of old rails available at low cost.

Details of Milling and Smelting

Lead Smelting Data of the Herculaneum Plant

The following tonnage figures of materials smelted and produced and fuel used are taken from the 1915 annual report of the St. Joseph Lead Co., Bonne Terre, Mo., and cover the operations at the Herculaneum plant. In the first table are given the tonnages of the materials smelted and of the resulting products. In the second table the tonnages are distributed to the different departments in which they were treated. The figures are complete and speak for themselves. Many sidelights on Missouri smelting practice can be found by a careful study of these two tables. This report is another case of commendable publicity concerning technical operations, which is becoming more and more the policy of progressive companies.

TONS OF MATERIALS SMELTED AND OF RESULTING PRODUCTS

Material	Produced Tons	Produced By	Used Tons	Used By	Balance on Hand.
Lead Bearing:					
Concentrate	121,495.13	Mills	121,351.72	Sint. Mc.	1,266.12
Flotation	14,920.24	Mills	12,197.93	Sint. Mc.	5,512.93
Rough matte	18,068.88	B. Fces.	23,610.90	Crusher	29,617.90
Crushed matte	23,610.90	Crusher	23,061.60	Wedge	734.08
Roast matte	22,675.72	W. & H. R.	22,798.27	Sint. Mc.	136.53
Gran. matte	18,734.37	B. Fces.	17,947.89	Sint. Mc.	786.47
Cr. sint.	1,819.00	Crusher	1,651.00	Sint. Mc.	168.00
Flue dust	839.87	B. Fces.	718.98	Sint. Mc.	153.18
Baghouse fume	2,488.47	Baghouse	2,333.97	B. Fces.	279.14
Sintered ore	223,252.69	Sint. Mc.	222,631.70	B. Fces.	1,131.38
Sintered matte	8,469.20	Sint. Mc.	8,606.69	B. F. & Cr.	None
Unrefined lead	91,716.27	B. Fces.	91,627.70	Refinery	204.80
Refined lead	84,356.52	Refinery	89,877.80	Sales Dept.	1,676.00
Lead B. sand	26,422.97	Shipper	19,011.60	Sint. Mc.	7,411.37
Slag	103,504.80	B. Fces.	29,448.10	B. Fces.	.....
Copper matte	.....	.....	.....	.....	730.76
Cr. sint. ore	111.70	Crusher	111.70	Sint. Mc.	.....
Fuel:					
Coal	24,185.14	Shipper	23,806.27	Disbm'ts	1,686.61
Coke	36,398.11	Shipper	34,395.16	Disbm'ts	2,743.05
Fuel oil	734,938.00	Shipper	675,211.00	Disbm'ts	89,809.00
Flux:					
Limerock	16,050.79	Quarry	15,190.40	B. F. & S. M.	1,700.60
Sand—quarry	11,127.13	Shipper	9,171.00	Disbm'ts	2,764.61
Pyrites cinder	53,452.32	Shipper	53,930.70	Disbm'ts	4,826.08
Iron cinder	None	Shipper	48.00	Disbm'ts	254.80
Chat	4,388.38	Shipper	4,230.58	S. M. & Disb.	4,157.90
Scale	39.90	Shipper	441.10	B. Fces.	None
Ingot drippings	31.81	Shipper	136.58	B. Fces.	.....
Spelter	18.00	Shipper	6.58	Refinery	11.42

TONS OF MATERIALS USED AND PRODUCED BY DEPARTMENTS

Accounts	Sint'g	Boilers	Wedge	Holthoff	Sundries	B. Fces.	Ref'y	Total
Amount of Fuel Used								
Coal, tons	479.7	18,887.0	159.0	88.0	913.3	0.7	3,288.6	23,806.3
Coke, tons	146.3	.....	.....	.....	183.9	34,036.6	28.4	34,395.2
Fuel oil, gallons	401,098.0	.....	72,321.0	131,018.0	.....	70,774.0	.....	675,211.0
Tonnage Used								
Concentrate	121,351.7	.....	.....	.....	.....	.....	.....	121,351.7
Flotation	12,197.9	.....	.....	.....	.....	.....	.....	12,197.9
Rough matte	.....	23,610.9	.....	.....	.....	.....	.....	23,610.9
Roast matte	22,798.3	.....	.....	.....	.....	.....	.....	22,798.3
Crush matte	4,328.5	.....	12,936.6	5,796.5	.....	.....	.....	23,061.6
Gran. matte	13,201.4	.....	2,866.0	1,880.5	.....	.....	.....	17,917.9
Flue dust	719.0	.....	.....	.....	.....	.....	.....	719.0
Sand—L. B.	19,011.6	.....	.....	.....	.....	.....	.....	19,011.6
Sand—quarry	9,171.0	.....	.....	.....	.....	.....	.....	9,171.0
Chat	4,139.9	.....	.....	.....	.....	.....	.....	4,139.9
Baghouse Fume	.....	.....	.....	.....	.....	2,334.0	.....	2,334.0
Limerock	208.4	.....	.....	.....	.....	14,982.0	.....	15,190.4
Pyrites cinder	45,134.5	.....	.....	.....	.....	8,796.2	.....	53,930.7
Iron cinder	.....	.....	.....	.....	.....	48.0	.....	48.0
Scale	.....	.....	.....	.....	.....	441.1	.....	441.1
Ingot drippings	.....	.....	.....	.....	.....	136.6	.....	136.6
Sintered ore	.....	111.7	.....	.....	.....	222,520.0	.....	222,631.7
Sintered matte	.....	1,819.0	.....	.....	.....	6,787.7	.....	8,606.7
Cr. sintered matte	1,651.0	.....	.....	.....	.....	.....	.....	1,651.0
Cr. sintered ore	111.7	.....	.....	.....	.....	.....	.....	111.7
Unrefined lead	.....	.....	.....	.....	.....	.....	91,627.7	91,627.7
Total	254,023.9	25,541.6	15,802.6	7,677.0	.....	256,045.6	91,627.7	650,719.4
Slag	.....	.....	.....	.....	.....	29,448.1	.....	29,448.1
Tonnages Produced								
Sintered ore	223,252.7	.....	.....	.....	.....	.....	.....	223,252.7
Sintered matte	8,469.2	.....	.....	.....	.....	.....	.....	8,469.2
Rough matte	.....	.....	.....	.....	.....	18,068.9	.....	18,068.9
Crush matte	.....	23,610.9	.....	.....	.....	.....	.....	23,610.9
Roast matte	.....	.....	15,281.3	7,394.4	.....	.....	.....	22,675.7
Gran. matte	.....	.....	.....	.....	.....	18,734.4	.....	18,734.4
Unrefined lead	.....	.....	.....	.....	.....	91,716.3	.....	91,716.3
Slag	.....	.....	.....	.....	.....	103,504.8	.....	103,504.8
Refined lead	.....	.....	.....	.....	.....	.....	84,356.5	84,356.5
Flue dust	.....	.....	.....	.....	.....	839.9	.....	839.9
Baghouse fume	.....	.....	.....	.....	2,488.5	.....	.....	2,488.5
Cr. sint. matte	.....	1,819.0	.....	.....	.....	.....	.....	1,819.0
Cr. sint. ore	.....	111.7	.....	.....	.....	.....	.....	111.7
Total	231,721.9	25,541.6	15,281.3	7,394.4	2,488.5	232,864.3	84,356.5	599,648.5

The Cost of Doing Things

Cost of Heating Buildings*

Formulas for estimating the amount of coal for heating buildings have been in use for several years. The writer has used two of these formulas—that of E. F. Tweedy, of New York, and that of D. S. Boyden, of Boston. Mr. Tweedy's formula employs the glass and wall surface, giving a value obtained on a number of buildings in New York City. The corresponding ordinate gives the tons of coal per heating season. In the Tweedy formula, tons of coal per year $= \frac{W}{4.5} + 2G$, where W is the net wall surface and G is the glass surface.

Mr. Boyden's formula is somewhat complicated, but in the writer's opinion it has the advantage that it takes into consideration a difference in the operating conditions in the different buildings. Experience is necessary in the use of this formula, however, as serious errors are likely to affect the variables to such an extent that the calculated result will be far from correct. The formula follows:

Tons of coal per year =

$$\frac{\frac{V \times a}{60} + (C_1 \times G) + (C_2 \times W)}{C_3 \times (130 - T)} \times L \times d \times h \times \frac{34}{e \times 2{,}000}$$

in which

V = Gross volume of the building, including basement, if heated;
G = Square feet of glass surface, 10% being added for north and west exposures;
W = Square feet of wall surface, 10% being added for north and west exposures;
a = Average air changes per hour during heating period;
C_1 = Constant for glass—1 for single glass;
C_2 = Constant for wall—usually 0.2 for brick and 0.3 for stone;
C_3 = Constant for local conditions—5.4 for Boston, 5.7 for New York;
T = Factor dependent upon the relation the heating plant bears to the premises heated;
L = Factor for portion of building not heated or for building heated to 70° F.;
e = Average evaporation in pounds of steam per pound of coal;
d = Number of heating days during season;
h = Average number of hours of heating per day.

Under normal operating conditions, when steam is on the heating system for from 3,200 to 3,500 hr. during the heating season of seven months, the two formulas agree fairly well with the actual results, as shown in the case of three buildings, as follows:

	Building No. 1	Building No. 2	Building No. 3
Actual coal, net tons	655	486	1,572
Tweedy formula	625	380	1,500
Boyden formula	650	469	1,545

While the three amounts agree closely in the case of buildings Nos. 1 and 3, for building No. 2 the result by the Tweedy formula is much below the actual, probably owing to the fact that much heat was wasted through leaky windows, increasing the amount of air change per hour.

Among those in charge of building operation for the United States Government, the practice is followed of assuming the condensation of 500 lb. of steam per square foot of radiating surface per season. The writer believes this to be a safe figure, as in the case of the three buildings cited the condensation approximated 400 lb., 430 lb. and 420 lb. per square foot per season respectively, assuming an evaporation of 7 lb. in each case.

The writer's method of estimating the coal requirements for heating a building is to employ the Tweedy formula and check with the Boyden formula and the Government method. A comparison of the results with the known requirements of a similar building completes the process.

While the amount of coal required depends largely on the amount of exposed wall and glass surface, yet it has been found that the total cost of operation bears a fairly well-defined relation to the volume of the building.

*Excerpt of a paper by George W. Martin in the "Journal of the American Society of Heating and Ventilating Engineers," from "Power," Feb. 15, 1916.

Operation and Maintenance Cost of Aerial Tramways*

At the Solvay Process Co., Syracuse, N. Y., the cost, including general expenses and taxes, for operating and maintaining the main-line aërial tramway (3¼ mi. long) and the quarry lines (aggregating 1¼ mi. in length) for transporting stone is approximately as follows:

Number of buckets per month	110,000
Gross tons per month	55,000
Cost per bucket, holding ½ ton each	$0.04
Cost per gross ton	.09
Cost per net ton	.08
Cost per ton-mile	.03

The cost of transportation over the short branch lines is less than 3c. per bucket, which, however, is more than 2c. per mi. because the main expense is at the terminals. In the main-line costs about one-quarter has to be transferred from the bucket to the line. These expenses do not include the cost of transferring the bucket from the cars to the rails, but only the cost of dispatching and receiving the bucket.

At the Eureka Slate Co., Slatington, Calif., the cost of transportation on a tramway operated directly by water power, requiring a maximum of 20 hp. when run at full capacity, is about 5c. per square (about 700 lb.). The line is 15,300 ft. long and has a capacity of 300 squares of slate in 9 hr.

At Sopris, Colo., the Colorado Fuel and Iron Co. has a line 2,370 ft. long, used for disposing of the waste from a coal washery. Self-dumping buckets are used, and the capacity is 20 tons per hr. The cost of operation and

*Abstract from "Aërial Tramways," by the American Steel and Wire Co.

maintenance is between 3 and 4c. per ton of material handled by this tramway.

The Cia. Manufacturera de Ladrillos Areniscos, Coah., Mexico, has an aërial tramway 1,950 ft. long, handling 500 tons of sand every 9 hr., at a cost of 4c. (U. S. currency) per ton. Considering the difficult manual labor in filling the cars from the river bottom, the management considers this a very reasonable cost.

At the Mond Nickel Co., Victoria Mines, Ont., Canada, a tramway 11,400 ft. long, used for transporting ore, capacity 25 tons per hr., shows a cost of operation of about 6c. per ton-mile on a basis of 150 tons per day, including loading and unloading.

At the Curwensville Fire Brick Co., Bolivar, Penn., a tramway 2,337 ft. long, capacity 20 tons per hr., is used for transporting clay. At present about 50 tons per day is handled at a cost of $3.50 to $4. Previously this was hauled on wagons at a cost of 45c. per ton, which would represent $22.50 for the quantity now being handled, which shows a saving of $15 to $20 per day by the operation of the tramway.

At the Washington Portland Cement Co., Concrete, Wash., a cableway 3,750 ft. long, with an hourly capacity of 60 tons, is used for transporting limestone. The cost per ton for transporting material over this tramway is as follows:

During 1909, carried	78,734 tons at	$0.03991 per ton
During 1910, carried	79,767 tons at	.02939 per ton
During 1911, carried	111,097 tons at	.03602 per ton
During 1912, carried	118,396 tons at	.06385 per ton
During 1913, carried	172,415 tons at	.02877 per ton

The cost for the first six months in 1912 was high, owing to the purchase of new track cables and additional rolling stock required to increase the capacity of the line from 45 tons to 60 tons per hr.

At Bingham, Utah, the Tintic Mining and Development Co. has run a tramway 2½ mi. long continuously for five years. The average tonnage moved amounts to 600 tons per day of 9 hr., and the cost has averaged 8¼c. per ton of material transported.

Cost of a Crosscut Adit*

The main working of the Portland Canal Tunnels, Ltd., consists of an adit 3,671 ft. in length; it crosscuts what is known as the fissure zone of Glacier Creek. The portal of the adit is about 3½ mi. north from Stewart, B. C., and 350 ft. above mean high tide at that point.

The heading, 7½x8 ft. in the clear, was driven a distance of 2,916 ft. at an average rate of 8 ft. per day. The best weekly record was 67 ft. and the best monthly 271 ft. Two 8-hr. shifts per day were employed, consisting of four machinemen and three shovelers. After the 1,000-ft. mark was passed, four shovelers were employed. Compressed air at 100-lb. pressure was delivered into the tunnel through a 4-in. pipe. Two 3¼-in. Ingersoll-Rand E44 drills, mounted on a 7-ft. single screw bar, were used. Miners and shovelers started work together. The bar was set up above the rock pile, and from 10 to 12 holes were drilled from this position. By this time the rock was out, the bar was lowered, and three lifters were drilled. The first 1,600 ft. of the tunnel is in greenstone, while the remainder is in argillites, quartz and porphyry.

With but two exceptions during the entire work, a round was drilled in every shift. Five-foot rounds were drilled, but seldom "bottomed." Three 20-cu.ft. cars were used, and tramming was done by the shovelers. The track of 20-lb. rails, 18-in. gage and ½% grade, was laid on the left-hand side of the tunnel. One switch, about half way in, was used; the empty incoming car was taken off the track near the face to allow the loaded one to pass. At a point 730 ft. from the portal an 80-ft. adit was run, opening into a cañon. This not only made an excellent dumping place, but shortened the tramming distance by 750 ft. The shovelers laid and leveled the track. The floor from within 3 ft. of the face to 40 ft. back was covered with steel plates before blasting. A drain 12 in. deep was made on the right side of the tunnel, the lifter being drilled low for this purpose.

Ventilation was provided by two Schütte & Körting blowers. The ventilating line consisted of 10-in. diameter 24-gage galvanized pipe. The pipe was made in 10-ft. lengths with riveted joints, painted with tar and wrapped with muslin. The compressor was run two hours after blasting to clear the tunnel.

TIME AND COST OF OPERATIONS

Average Time of Operations

	Hr.	Min.
Picking down and setting up	1	00
Drilling from upper set-up	4	30
Shoveling back and lowering bar	0	30
Drilling from lower set-up	1	15
Tearing down	0	10
Blowing out holes	0	5
Loading	0	15
Total	7	45

Detailed Summary of Costs

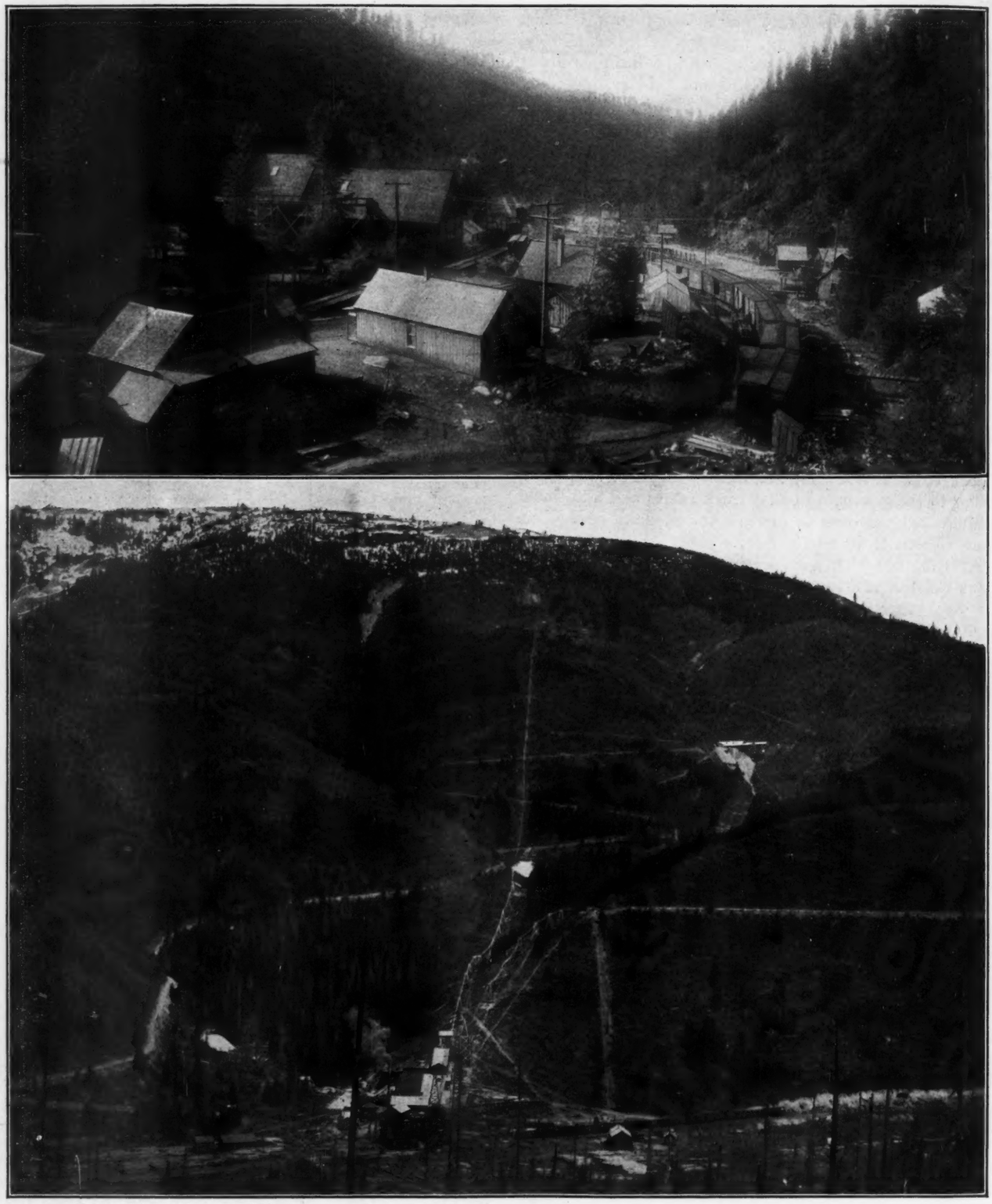
	Cost per Foot
Labor:	
Machine men	$3.953
Shovelers	3.673
Timbering	.258
Drainage	.042
Ventilation	.077
Ties and wedges	.135
Compressed-air line	.072
Compressor men	1.166
Blacksmith and helper	1.216
Superintendent	.876
Total	$11.468
Supplies:	
Powder	$2.562
Fuse	.134
Caps	.032
Candles	.145
Blacksmith coal	.125
Machine drills and parts	.503
Drill steel	.118
Timbers	.052
Repairs on compressor	.027
Oils	.031
Miscellaneous	.073
Total	$3.802
Equipment:	**Total Cost**
Muck sheets	$110.00
Steel rails	1,290.00
Ventilators	225.00
Ventilating pipe	960.00
Compressor air line	1,070.00
Cars	400.00
Total	$4,055.00
Length of tunnel	2,916 ft.
Total cost	$48,584.01
Cost per foot	$16.661

All supplies were bought at Vancouver, B. C., and sent north by steamship. The prices of some of the more important supplies at the tunnel were as follows: Dynamite—40%, $0.134 per lb.; 60%, $0.159 per lb. (powder was used in about the proportion of 30% of the former to 70% of the latter); steel rails (20-lb.), $72.24 per long ton; blacksmith coal, $27 per ton.

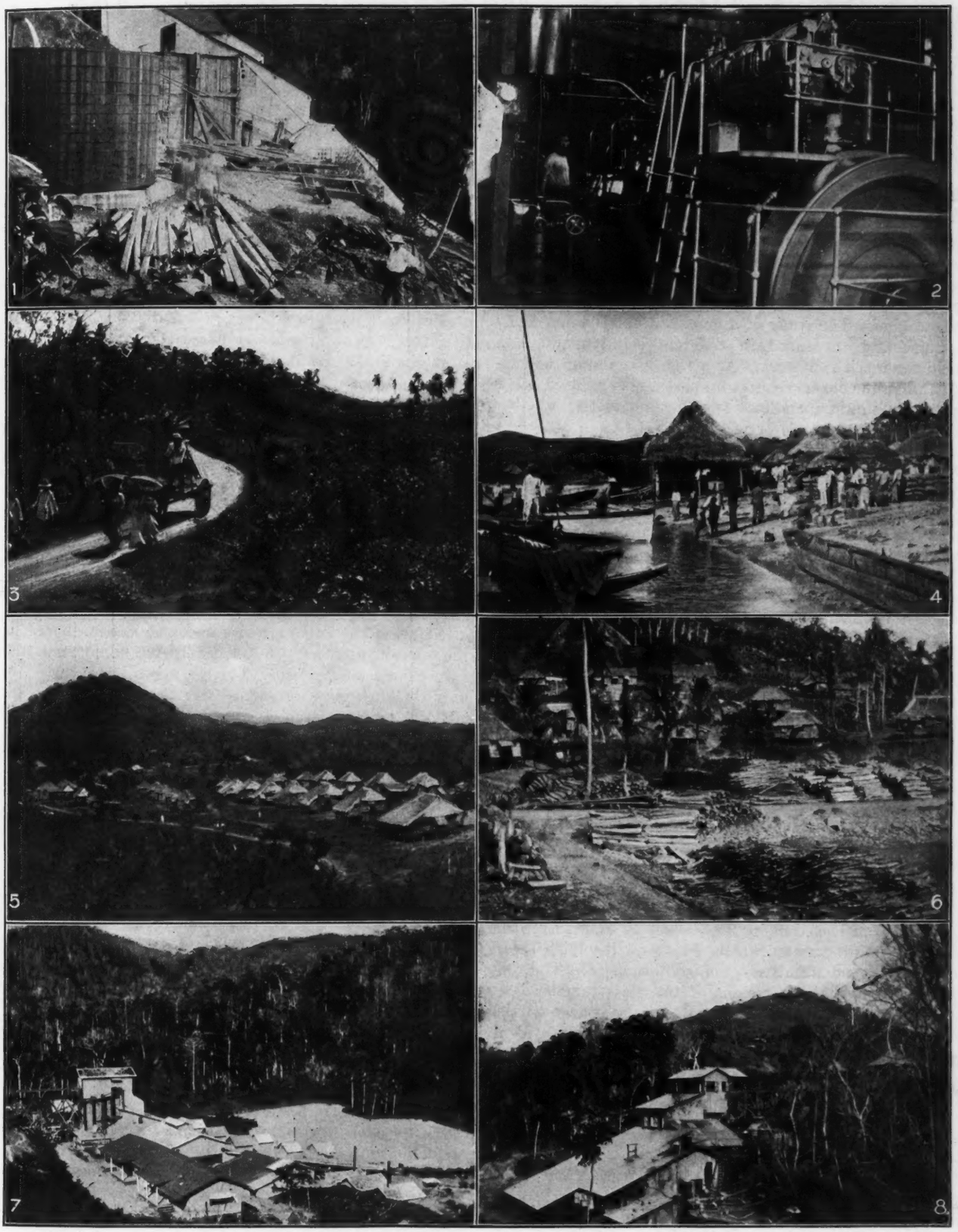
The scale of wages was as follows: Machinemen and shovelers, $4 per day; blacksmiths and compressor men, $5. Beyond the point to which these figures apply, the size of the tunnel was cut down and the costs decreased about $1 per foot.

*Excerpt from paper by W. J. Elmendorf, "Trans. Can. Min. Inst.," 1915.

Photographs from the Field



TWO VIEWS IN THE COEUR D'ALENES. THE UPPER SHOWS THE PLANT OF THE TAMARACK & CUSTER CONSOLIDATED MINING CO., AND THE LOWER THE OLD SNOWSTORM PLANT AND VICINITY



VIEWS IN THE MINING DISTRICT OF AROROY, MASBATE, PHILIPPINE ISLANDS

1—Excavating for the 500-hp. Diesel engine foundation, Colorado Mining Co. 2—Diesel engines installed at the Syndicate mill. 3—Native transportation on the road to Aroroy. 4—Unloading from boats at the Aroroy landing. 5—The barrio, native quarters of the Colorado Mining Co. 6—Timber yard of the Colorado Mining Co., on the Guinobatan River. 7—The Syndicate Mining Co.'s 115-ton mill at Aroroy. 8—The 50-ton cyanide mill of the Keystone Mining Co. at Aroroy

The Control of Ore Slimes--III*

By Oliver C. Ralston†

SYNOPSIS—Continuing the discussion of slimes control. The electric-charge character is mentioned, and the action of various substances on slimes. Precipitation by chemical re-agents is studied.

The amount and sign of the electric charge on a suspended particle depends entirely on the composition of the solution in which they are contained, so that it is possible to make this charge either positive, negative or zero, by the use of the proper proportions of the proper electrolytes. The study of different minerals when finely ground and suspended in different solutions offers a field for much new work. As a rule flocculation will result when the electric charge on particles is reduced below a certain minimum allowable value, no matter whether the charge be positive or negative.

In Fig. 7 is given the contact-potential of the oil-water contact surface in an oil emulsion, as measured by Powis[19] who has obtained a like series of curves for the glass-water contact surface. For measuring the polarity and size of the electric charges on oil droplets Powis has used a method that is the same as that described for making such measurements on ore particles in the beginning of this paper. The addition of various amounts of the electrolytes mentioned in the curves changed the contact-potential of the particles of oil, and one sees that the exact potential of the particles of oil toward the solution varied greatly with the material in solution. The concentration of the electrolytes used differed so widely that the cube roots of the concentrations were plotted instead of the concentrations themselves, in order to get all of the data conveniently on one diagram. By use of the proper electrolyte it was possible to increase the negative charge on the oil, to decrease it or even to lower it to zero and pass over to a positive charge. Powis' data on the contact-potential of a glass-water surface were obtained between the glass of a microscope slide and the water on it and were similar to the diagram of the oil-water surface. So one can see that the electric charges are carried not only by small particles, but by larger ones as well. Even the glass containing water which stands on the table before you is charged negatively toward the water. The only difference is that the weight of the glass tumbler is so large compared to the magnitude of the charge carried on its surface that the charge is not ordinarily evident. However, I have seen the electric effects on enough ore particles and oil droplets to feel that they must be of importance. The results of this theory have also been prolific, as will shortly be seen.

Ellis,[20] working with emulsions of cylinder oil, has found that it is negatively charged when emulsified in water and that the addition of colloidal hydrate of iron in gradually increasing amounts lowers the charge of the oil droplets, as the iron hydrate is positively charged, and the electric charge of the resulting complex particles is the resultant of the charges of the two colloids. The contact potential curve passes through zero from the negative side to positive potentials when the iron hydroxide predominates. When the potentials of the particles of the complex were between —0.04 and +0.035 volts, the suspension was unstable and tended to flocculate. When the potential of the particles was greater than these two values, whether positive or negative, the suspension was not flocculated and was stable. In mechanical terms it would seem that with the particles charged sufficiently strongly, with either positive or negative electricity, they will repel one another with sufficient force so that they will not flocculate. When the potential of the charge reaches a certain minimum allowable value, the particles do not repel one another with sufficient force to prevent them drawing together by some other unknown force and flocculating. This would explain why there is a certain definite threshold concentration of a flocculating salt below which there is no noticeable effect and after reaching which flocculation is practically complete without further addition of salt being of any advantage. A sufficient amount of this electrolyte will often cause the colloid to assume an electric charge of the opposite sign and of sufficient potential to make the suspension stable again. This is to say that there are only certain concentrations of these electrolytes that are effective in flocculation and above or below these concentrations the action is that of deflocculation.

Control of Electric Charges

This explanation should be sufficient to make clear what was the exact purpose of using the electrolytes and other substances the effects of which are summarized in Table 4. It was perfectly feasible to take an ore slime, to deflocculate it so that it would not settle, to flocculate it to any degree so that it would settle more and more rapidly, or otherwise to control it.

The data in Table 4 are the observations on the relative rates of settling of the respective slimes (four in number) in pure water and in solutions of various materials. In each test, where not otherwise stated, the initial density of the pulp was 9.4% solids. This particular density was chosen as there are few instances in modern ore dressing in which more dilute pulps are being thickened, and moreover this density is fairly common. On the two oxidized ores, which ordinarily settled completely in 15 min., the relative distance settled in the first 3 min. was used for comparison. With the two sulphide-ore slimes, which settled fairly completely in one-half hour, the distance settled during the first 5 min. was taken as an index of the rate of settling, so that the percentages of increase or decrease of speed of settling could be calculated for use in Table 4. The tabulation of the complete data obtained in these tests would have been beyond the purpose of this paper and will later be incorporated in a more extensive treatise.

*By permission of the Director of the United States Bureau of Mines.

†Communicated by D. A. Lyon, metallurgist in charge of Salt Lake station, in coöperation with the metallurgical research department of the University of Utah. O. C. Ralston, assistant metallurgist, Bureau of Mines.

This is the seventh of a series of articles treating of "Colloids in Ore Dressing." Former articles appeared in the "Journal" of Feb. 5, Mar. 4, Mar. 18, Apr. 15 and 29 and May 13, 1916. The eighth will discuss "Slime Cakes" and will appear in an early issue.

[19] "Zeit. physik. Chem.," Vol. LXXXIX, p. 91 (1914).

[19] "Zeit. physik. Chem.," Vol. LXXXIX, p. 91 (1914).

In order to see if the same relative changes of velocity take place when a given amount of electrolyte is added to pulps of different densities, three different densities of

TABLE 4. EFFECT OF VARIOUS SUBSTANCES ON SLIMES

Substance	Horn Silver Slimes	Grand Central Ore	Bullion Coalition	Ophir Hill
Oxalic acid....	Increasing amounts up 0.08% give increasing effect, decrease speed 40%	Amounts up to 0.04% give no effect		
Carbolic acid....	No effect			
Citric acid....	0.0125% decreases speed 31%, 0.05 decreases speed 33%, 0.10 decreases speed 22%, NaOH increases dispersion	0.01% deflocculates the ore, especially the iron	0.0125% lowers speed 80%	
HCl.....	0.025% lowers speed 16%, final density unaffected	0.025% lowers speed 5% 0.204% lowers speed 15%		
H_2SO_4...	0.94% lowers speed 11%, 0.16% raises speed 6%	Very slight effect dispersing		0.0516% lowers speed 10 %
NaOH...	0.025% raises speed 41%, final pulp 30 % solids	0.0516% deflocculates iron, differential settling, 0.4% speed increasing	0.0258% deflocculates ore	0.0516% raises speed 37%
Na_2CO_3..	0.05% raises speed 46%, final % solids, 35%	0.026% deflocculates iron, 0.050% deflocculates completely		
Sodium silicate..	Slight lowering speed, 0.1% gives 32% final solids, 0.4% gives 24% final solids	0.02% lowers speed 5%, 0.05% deflocculates	0.0516% deflocculates H_2SO_4 flocculates and settles faster	
$FeSO_4$...	0.82% lowers speed 30%, smaller amounts less effect	Small effect, line appeared higher		
Alum....	0.025% lowers speed 23%, this is minimum speed	0.0258% slight deflocculation		0.2% lowers speed 7%
NaCl....	No effect up to 1%	No effect	No effect	
$Ca(OH)_2$.	0.00625% raises speed 18%			
Tannin..	0.025% lowers speed 60%	0.0516% deflocculates, 0.10% alum flocculates	0.026% deflocculates, sands settle	
Gelatin...	0.0013% raises speed 90%, final material 32% solids	0.0006% raises speed 50%, 0.0012% raises speed 90 %	0.006% raises speed 5%	
Saponin..	0.005% lowers speed 21%, greater effect on standing over night	0.005% lowers speed 12%		
Egg albumin.	Very small effect	Slight deflocculation		
Glue.....	0.0001% raises speed 32%, 0.005 % raises speed 48 %	0.0001% raises speed 50%, 0.001% raises speed 80%		
Soap.....		0.00516% raises speed 62%		
Ox blood.	0.5% completely deflocculates			

Horn Silver slimes were tested with varying amounts of lime water. The results are given in Table 5, for the distances settled during the first 5 min.

TABLE 5. ELECTROLYTES ON PULPS OF DIFFERENT DENSITIES

	% Solids	% CaO Added 0	0.0031	0.00625	0.0125	0.025
Percentage increase in velocity	5	0	17%	39%	39%	35%
	10	0	1	18	7	20
	20	0	0	3	3	4
Location of "Line"	5	23 c.c.	34	60	70	96
	10	67	...	160	190	180
	20	197	197	197	198	198

From this table we see that the dilute slimes suffered the greatest percentage increase in velocity owing to the addition of lime in small amounts. As the particles actually settle faster in thin pulps than in thick ones, this great increase in velocity makes even wider the gulf between the thin and thick pulps. It will be noticed that the denser pulp is hardly affected.

The position at which the line appeared on the 200-c.c. graduate was higher up in each test, indicating that the change from subsidence settling to consolidation settling took place in more and more dilute pulp as more lime was added. It was further noticed that the final settlement was to a thickened pulp containing more and more moisture. This is a disadvantage that seems to come with flocculation of the ore in order to make it settle faster. The same disadvantage does not accrue with slimes that are caused to settle faster by heating the solution.

Flocculation by Organic Colloids

The action of organic colloids toward suspension colloids is of two different kinds. In case the particles of the organic colloid are of the same electrical sign as those of the suspension colloid, we have the so called protective effect of these colloids, as the resulting sol will be more difficult to flocculate by the use of electrolytes than was the original supensoid. Most of the organic colloids are more stable in this way than are the inorganic suspensoids, since they often consist of some true solution as well as some colloidal material. A parallel to these semi-colloids is found in certain supersaturated solutions of sodium chloride, in which an excess of finely divided salt can be held in colloidal solution in a saturated solution of sodium chloride in water. In case the organic colloids (there are also a few inorganic colloids that act in the same way; for example, silicic acid, ferric hydrate and several sols which are doubtless emulsoids), have the opposite electric charge to that of the suspensoids, the particles of the oppositely charged colloids combine into larger composite particles and are often flocculated to a high degree, so that they settle rapidly.

As most ore slimes consist of particles some of which are charged with one sign of electricity and others with the other, there is generally some flocculation when many of these organic colloids are added; in fact, many of them have proved to be efficient flocculators on the ores tested in this work, as can be seen in Table 4. This effect was one of the main discoveries of the present research and was surprising indeed, as the opposite effect of protection had been expected. The high efficiency of gelatin in flocculation, in which 13 lb. of gelatin to 1,000,000 lb. of water produced an increase in the rate of settling of the Horn Silver slimes of about 100%, is to be noted. One set of the settling curves on these slimes is shown in Fig. 8. At the same time the effect on the Bullion Coalition slimes was to slightly decrease their speed of settling. This shows that the best flocculating agent for one ore may do no good at all with another ore.

On investigation of the literature and inquiry of other metallurgists, the writer learned that this effect of organic colloids was not entirely unknown, although it had not been recognized as a general law. In Richards "Ore Dressing" [21] is found the statement that at the West Yankee mill, as well as at the mills of the Arizona Copper Co. and of the Shannon Copper Co., some salts and acids collected in the mill water, which were neutralized with

[21] "Ore Dressing," Vol. IV, p. 1414.

lime and the settling hastened by the addition of a little soap. Soap is a cheap semicolloid. An emulsion of 39 parts pine oil, nine parts soap and 59 parts water has been patented by Littleford[22] and assigned to the Minerals Separation, Ltd. This emulsion is said to flocculate the ore colloids and allow a better separation of the metallic sulphides in any concentration process. Doubtless the flotation process is one of the main processes referred to, for the reason that it is a very important matter to obtain clean flotation concentrates when the gangue is very colloidal and some method of coagulating the slimes of the gangue seems necessary. Oleic acid is a good flotation oil, and the sodium oleate and related substances in soap will probably make soap one of the most desirable materials for the control of ore slimes in connection with the flotation process.

Coagulation and Flotation

Aside from the subject but apropos of flotation, the froth of a flotation machine, when viewed in a glass window in the side of the machine, has the appearance of coagules of sulphides, as though the oil or other agent had flocculated the sulphides. The gangue, to sink away from the froth quickly, should also be flocculated. While acids, alkalies and other addition agents may have other functions, they can easily have a coagulating effect on portions of the ore. Chapman[23] and Minerals Separation have taken out a patent for a method of flocculating gangue slimes which consists of the use of any of a number of weakly dissociated organic acids, like tartaric acid, whose action of coagulation is slow enough to allow a sulphide froth to be formed before the floccules of gangue are formed and thereby no particles of sulphides are entrained in the gangue. This slow action of such compounds is ascribed to the fact that they are only weakly dissociated. It is claimed that test work at Anaconda and at the Burro Mountain Copper Co., using argols, the commercial potassium acid tartrate, has been very promising. Sulman[24] and Minerals Separation likewise claim the use of a fluosilicide in place of acid when colloidal ore slimes are encountered.

I am further privately informed that flour has been found of assistance in the settling of the Miami slimes. J. V. N. Dorr has told me that clays and dirt are settled from solutions at the nitrate works in Chile by the addition of manure. The use of solutions of glue or of gelatin[25] in connection with a sulphate of a heavy metal, like the sulphates of iron, zinc or copper, mixed into a solution so that one part of glue and one part of iron sulphate are contained in 2,500 parts of water may be efficient. One gallon of this solution added to 17 gal. of the effluent water from a gold, copper, lead or other mill, followed by gentle stirring for a few minutes, will cause the settling out of all the suspended matter. While French ascribes this action to a film of the colloid causing each ore particle to lose its affinity for the water, experiment will convince anyone that it is a case of flocculation. Glue is seen to be an efficient flocculent of some of the ores experimented on and reported in Table 4. In fact, the Horn Silver slimes are somewhat oxidized, owing to weathering, and soluble sulphates are detected. This doubtless explains the high efficiency of gelatin on this ore, as the heavy metals are known to be good coagulators of gelatin[26]. This is known as "salting out." Mr. Laist, of the Anaconda Copper Co., has informed me that he has tested glue and several of the heavy metal sulphates on the Anaconda slimes with satisfactory results, and that it would be feasible to use this method in case they ever needed an increase in settling capacity and in case the glue or other addition agents did not interfere with subsequent flotation treatment of the slimes. This latter point is well taken, as glue is known to be deleterious to flotation. However, it is a desirable addition agent in the electrolytic deposition of zinc and other metals from solutions and may find use to a considerable extent in the new hydrometallurgy that is springing up.

Henry Bailey[27] has patented the use of colloidal sulphur in the treatment of slimes from tin and other ores, the colloidal sulphur acting to flocculate the ore in the manner already described. The sulphur emulsion is prepared by decomposition of an alkaline or alkaline-earth polysulphide with an acid or by the action of an acid on a thiosulphate. Free sulphur in the colloidal state is liberated in these reactions.

Preferential Flocculation

Schwerin[28] has likewise taken out two patents, one of which is for the purpose of "separating substances in suspension" and claims the addition of "suitable electrolytes to the substances in suspension." The ideas mentioned are largely in the treatment of clays and of peat, while ores are not mentioned, although the wording of the patent could allow its extension to cover ores. As the coagulation and settling of colloids by electrolytes has been known for some time, it is doubtful if a patent of such general claims could hold, especially as it is dated May 30, 1911. Schwerin's second patent, just mentioned, states that some substances in suspension seem to be inactive toward electrolytes and that they can be made active by the addition of the proper colloids, such as silicic acid, so that they will be caused to act more like colloids. This is doubtless what has been happening when organic colloids and electrolytes are used simultaneously, as in French's patent. All the foregoing methods of flocculating slimes by the use of organic colloids might easily be explained by the assumption that the organic colloids are adsorbed onto the surfaces of the weakly acting ore particles, rendering them more sensitive toward electrolytes. Freundlich and Brossa[29] have recently noticed a "sensibilierung," or sensitizing of albumin sols toward electrolytes by the addition of a suspension of ferric hydrate. They likewise assume that larger particles of a complex of the two colloids are formed and state that several cases of "sensitizing" are in the literature, but that it had not been recognized as a general phenomenon. An inspection of Table 4 will reveal the fact that some of the organic ions have effects that are peculiarly their own and that do not fall in line with those of other electrolytes. As an instance, citric acid tends to deflocculate most of the ores to which it is added and sodium hydrate added subsequently will not counteract its effects. This behavior of organic electrolytes is well known to colloid

[22]U. S. Pat. No. 1,142,822, June 15, 1915.
[23]British Pat. No. 17,327, of July 21, 1914.
[24]British Pat. No. 4,938, of Feb. 25, 1914.
[25]A. G. French, U. S. Pat. No. 1,065,678.
[26]W. W. Taylor, "The Chemistry of Colloids," p. 124.
[27]British Pat. No. 18,490, of 1912.
[28]U. S. Pat. Nos. 993,888 and 1,029,579.
[29]"Zeit. physik. Chem.," Vol. LXXXIX, p. 307 (1915).

chemists, and any good text on colloids will mention the unclassifiable effects of these electrolytes—especially those containing organic anions.

Finding that many of the organic colloids flocculated ore slimes and believing that it was in some way connected with salting out or else with Freundlich's sensitizing, it was assumed that any insoluble chemical precipitate, if produced in the body of the ore slime, should tend to bind the particles of the slime into flocks which would sink faster. Thus alum followed by sodium hydrate reacts to give an insoluble precipitate of aluminum hydrate which is also colloidal. The Grand Central slimes, when treated with a definite amount of alum followed by sodium hydrate, gave quick satisfactory settling. When the sodium hydrate was added first and the alum some time later, although the reagents were used in the same amounts as in the experiment cited, the slime would not settle any faster than the original slime. As sodium hydrate tends to disperse this ore, it was probably well adsorbed and reacted on by the ore, so that the alum did not have an opportunity to form aluminum hydrate to any great extent. This same ore, when treated with first sulphuric acid and then sodium hydrate, increased its rate of settling, and the same result was obtained by adding the reagents in the reverse order. Thus the order of addition of reagents makes a considerable difference in some cases and no difference in others. Each ore seemed to have its own peculiar characteristics in this way, so it is unnecessary to multiply instances. Each particular ore contains so many different minerals and in such different physical arrangement from other ores that intelligent guesswork in the application of reagents seems to be all that is possible at the present time.

TABLE 6. FRACTIONAL SETTLING OF GRAND CENTRAL ORE

100 Grams Ore (200-Mesh) in 1,000-C.C. Graduate, Filled with Water, 0.0518% Na_2CO_3

	Heads	Settled	Suspended	% of Total in Suspension
Weights	100 gm.	49.00	51.00	51.0
Copper	1.005%	0.47	1.52	77.1
Silver	7.49 oz.	3.86	11.00	74.7
Gold	0.241 oz.	0.13	0.30	68.5
Iron	12.46%	9.80	15.00	61.5
Insoluble	67.90	76.80	59.40	44.6

The ambition of the slimes engineer should be to deflocculate one group of minerals while another set will settle out. This has been attained in the case of Schwerin's British Pat. No. 19,313 of 1914, described elsewhere in this paper, where he was able to get a concentrate of iron ore by settling in solution.

The writer observed a similar effect with the oxidized ore of the Grand Central mine. When an alkaline dispersing agent, such as sodium hydrate silicate or carbonate, was added to a pulp of this ore containing 10% of solids, the reddish iron claylike material became deflocculated and subsided very slowly, while a dark-colored siliceous material settled out immediately. In pure water there was no such separation. The analyses of these fractions are appended in Table 6. This material, before pulping, had been passed through a 200-mesh sieve. The black, coarser siliceous material that settled first might be regarded as sands and the red material as slimes, but it was also perfectly feasible to deflocculate the black material as well by addition of more defloccuating agent. Still the grains of the dark material could be distinguished by the microscope, while those of the red material were impalpable.

In the table we see that the greater portion of the copper, gold and silver of this ore remained with the oxidized iron compounds that remained suspended in the water.

Another test on somewhat coarser material gave a deflocculated iron product carrying 4% Cu, 21 oz. Ag and 0.75 oz. Au, but the extractions of the three metals were only slightly over 50% and were regarded as unsatisfactory.

These results show that there is a considerable possibility of putting this method to some commercial account, for certain types of ores. The writer was not able to make the other three ores separate in any such marked fashion, although promising indications were given by the calamine ore, where the iron minerals again showed a tendency to be dispersed before the zinc minerals.

Instances might be multiplied of the various possible methods of controlling ore slimes, but it is the purpose of this paper to be suggestive rather than exhaustive. The fact that each ore is individual in the way it reacts toward addition agents makes it difficult to give general statements as to the value of any particular addition agent for controlling the properties of slimes. In spite of this, a short summary of the properties of these addition agents and the ways in which they will usually react is given in Table 7. This sumary is based largely on the experience gained in this research.

TABLE 7. EFFECT OF ADDITION AGENTS

Inorganic Electrolytes:

Sodium chloride is rarely an effective addition agent for either flocculation or deflocculation of various slimes, and when added to water to any extent demanded by the ore, is likely to increase the viscosity so that the particles will settle slowly in any case.

Ferrous sulphate, the copperas of commerce, is a fairly efficient flocculating agent for negatively charged particles by virtue of the fact that the heavy bivalent ion of iron is strongly absorbed by the colloid particles. It is a deflocculator of positively charged particles under some conditions.

Zinc sulphate, copper sulphate, magnesium sulphate, magnesium chloride, calcium chloride, etc., act in the same way as iron sulphate. Magnesium and calcium chlorides are being used for flocculating slimes in the overflow water of many German ore-dressing plants.

Alum and other aluminum and ferric salts containing trivalent positive ions are often tremendously effective in the flocculation of negative ore particles.

Sulphuric acid and hydrochloric acid are often effective coagulants of negative colloids owing to the hydrogen ions.

Sodium hydroxide is a most effectve deflocculator of negative colloid owing to the strong adsorption of the hydroxl ions. It will flocculate positive colloids, owing to the same cause.

Sodium carbonate, owing to its alkaline reaction, will generally react in the same way as sodium hydrate.

Sodium silicate—This salt hydrolyzes into sodium hydrate and colloidal silicic acid, which carries a negative charge. Both of these products will tend to disperse or deflocculate a negatively charged ore slime, and hence sodium silicate is one of the most effective agents of this kind, although its full effect is felt rather slowly.

Lime—The bivalent calcium ion is more strongly adsorbed than the hydroxyl ions and hence lime usually coagulates negative colloids. It is widely used for that purpose in cyanide mills. Its effect is the opposite of that of sodium hydrate, in which the hydroxyl ion is predominant. The adsorbed ions have been found to be carried down with the precipitated colloids, as has been shown by any number of experimenters.

Organic Electrolytes:

As mentioned in the body of the article, these substances react in many diverse ways. Citric acid and oxalic acid and their sodium salts have been found to deflocculate most ores. Acid tartrates are said to slowly flocculate the negatively charged slime particles. This field has been almost untouched by metallurgists.

Organic Colloids and Semicolloids:

Tannin seems to deflocculate nearly all ore colloids and is known to affect clays in the same way. Inorganic electrolytes in sufficient amounts will reflocculate the slimes so treated with tannin, but the colloids have been protected by the tannin so that these electrolytes are less effective than on the untreated ore. It produces its maximum effect after standing several hours. It is very deleterious in flotation, although its solutions foam well.

Saponin, the substance used to make beer foam, has an effect similar to tannin.

Albumen, from the white of an egg, is more or less indifferent, but tends to deflocculate most ore slimes.

Ox blood, which contains albumin among other things, is a strong deflocculator and its effects are very hard to counteract.

Soap is an effective flocculating agent with many negative slimes, giving large fast-settling flocks.

Glue tends to flocculate most ore slimes efficiently, especially in the presence of electrolytes, and is known to be bad for flotation.

Gelatin is also an excellent flocculator.

Starch has not been experimented with, but the good effect of flour at Miami is probably due to starch.

Any of the foregoing colloids can be salted out by electrolytes and thereby cause flocculation of the ore slimes in which the process takes place.

The various methods for the technical control of ore slimes have been discussed critically and supplemented by experiment, and the general conclusion is that the laws of colloid chemistry are applicable to ore slimes. The experimental results seem to justify the conclusion in every particular. The processes of flocculation and deflocculation play an important part in the various methods that have been proposed to treat slimes for separating certain minerals or for settling them, or for suspending them permanently in the liquid for any desired purpose. Organic colloids have been found to be peculiarly effective agents to use in the control of ore slimes, especially in conjunction with electrolytes.

Bunker Hill & Sullivan Mining and Concentrating Co.

The report for the year ended Dec. 31, 1915, of the Bunker Hill & Sullivan Mining and Concentrating Co., Kellogg, Idaho., states that operations were continued at full capacity throughout the year, with slightly increased output over former years and with the maintenance of usual efficiency.

Owing to increased metal-market prices and receipts from other sources, the net available surplus for the year amounted to $1,819,888, from which dividends aggregating $1,062,750 were paid.

The Caledonia and the Sierra Nevada Consolidated, owners of adjoining properties which were under the Bunker Hill management, paid to the latter company dividends totaling $532,557. The Caledonia company produced at full capacity during the year and has contracted for the sale of its output until Jan. 1, 1917. The Sierra Nevada Consolidated ore-selling contract to the American Smelting and Refining Co. expired Apr. 29, 1915, and the smelting company refused to renew or extend it, or to receive the Sierra Nevada ore other than under new terms equivalent to an advance of from $4 to $6 per ton, depending upon the metal market. As it has not been possible to find a market with any other smelting company for these ores at the former rate or at what seemed a fair rate to the Sierra Nevada company, it has not sold any ore since Apr. 29, 1915, and no production has been made and only moderate exploration and maintenance work has been done since.

The Kellogg, or mine, cost per pound of lead during 1915 was 1.50c., exactly the same as in 1914 and 12% lower than the 1913 cost. At the same time there has been an increase during the year in the smelting company's charge per pound of lead from 1.91c. for the year 1914 to 2.70c., which has made the average charge for 1915 amount to 2.40c. per lb.—an increase for the year of over 25% as compared with the same cost for 1914. This increase in charges of the smelting company is largely due to the expiration on June 1, 1915, of a modification of the smelting contract made in 1910, which modification the smelting company has refused to renew. Relief from this situation by the electrochemical method for the reduction of these ores, mentioned in former reports, have been continuously applied during the year with encouraging results, but the method in practical detail is not yet sufficiently developed to justify proceeding on a larger scale than the experimental small tonnage plant now in use.

Because of these facts and because there is practically 10 years' ore supply in the mine and deep development work and geologic conditions are highly favorable for additional decades of mining life, the company felt fully justified in making plans to substantially increase output and to provide smelting facilities for the better conserving of the metals in their own ores and the ores of affiliated mining companies.

Outlays for experimentation, improvements and additions to the concentrating plant have been amply justified by the market increase in the recovery of the metals in the ores, and a still further increase is expected.

The case against the Stewart Mining Co. for removing ore from the Saxon claim was settled favorably to the company, and there is no other litigation pending to which the company or any of its affiliated companies is a party.

Successful exploration work has been conducted regularly on the No. 14 level (bottom), 1,000 ft. vertically below the Kellogg tunnel, and all conditions of formation and ore occurrence were found to be normal.

The ore reserves blocked out to date are: Stemwinder mine, 19,389 tons; Sullivan mine, 748,152; Bunker Hill mine, 2,806,389; making a total of 3,573,930 tons.

The Mines of Tonkin Invite American Capital

Mining in Tonkin offers especial opportunities to American capital, according to American Consul Lawrence P. Briggs, Saigon, French Indo-China, who states that Tonkin is rich in minerals and the expected market value of the output for 1916 is $3,000,000 for coal, $1,500,000 for zinc, $1,500,000 for tin and tungsten, $1,200,000 for cement and $300,000 for antimony. Manganese, copper, lead, iron, silver, gold and phosphates are known to exist and have been produced, but in small quantities, as shafts and mining machinery are practically unknown and the mining is almost exclusively by coolie hand labor in surface operations which are little more than stone quarries.

Up to Jan. 1, 1916, about 120 mineral concessions had been granted, of which only a small proportion had been exploited. The mineral production for 1916, on account of the stimulus due to the European War, will be greater than in any preceding year. Tin, tungsten and antimony mines were never successfully operated before the war, but were called to life by the enormous demand and excessive prices for these minerals on this account.

Backward development has been due to lack of capital, and in the absence of sufficient French funds to meet the needs of the industry, it is hoped that American capital will investigate this field. The only successful coal mine, that of Hongay, produced 90% of the entire output and is controlled by English capital. Most of the zinc mines were financed by German firms, which carried the products to refineries in Belgium and Germany.

Ownership, or at least the nominal control of mines, must remain French, according to the mining laws of Indo-China. According to these laws no mine can be owned or exploited except by a citizen of France or native of Indo-China, or by a company organized according to French law, with its headquarters in France or its dominions and with the majority of its administrators citizens of France or natives of its dominions.

Military Motor Trucks for the Border

An order has just been filled for the United States Government for thirty 3-ton motor trucks of the Riker type, one of which ran from Columbus, N. M., to El Paso, Tex., over the rails of the El Paso & Southwestern Railway system, making the run of 93 mi. at an average of a little better than 19 mi. per hour. The truck carried 20 soldiers with their complete equipment and, on arrival at El Paso, was derailed and driven up the main street to General Scott's hotel, where the General inspected it and pronounced the test satisfactory. This run was made possible by a flanged rim device which

MILITARY MOTOR TRUCK IN THE SOUTHWEST

is clearly shown in the illustration and which was invented and developed by A. L. Riker, vice-president and chief engineer of the Locomobile Co. of America, which filled the order for the Government. Mr. Riker is chairman of the committee on Internal Combustion Engines of the United States Consulting Board.

The order for the 30 trucks was placed Monday morning and was filled in every detail Tuesday afternoon. The trucks were loaded on a special train in the yards of the Erie Railroad in Jersey City, and were shipped directly through to San Antonio, Tex. Forty-one mechanics and drivers accompanied them on a special train consisting of engine, Pullman, sleeper, diner and express cars. It is expected that these trucks will go into immediate service on the Mexican border.

Nine Distinct Seismic Disturbances were recorded at the Balboa Heights observatory, Canal Zone, during the month of April. They varied in intensity from 1 to V on the Rossi-Forel scale of I to X.

Cause of Rand Earth Tremors

By A. Cooper Key*

The Witwatersrand Earth Tremors Commission has issued its report. The word "shock" would appear more suitable than tremor. Shocks extend broadly over an area with a radius of 4 mi., and their frequency and intensity have increased. In three cases the intensity exceeded 10 mm. on the seismograph record, the worst being on Sept. 28, 1915, with 15.5 mm. From the progressive upward tendency it may be inferred that still severer shocks than any felt before are probable. The amplitude of record must not be confused with amplitude of shocks, as the instrument magnifies the movement very largely and the ground probably moves to the extent of a fraction of a millimeter. To test the violence of the shocks, a leveled plate was put in a room on the first floor of the Cullinan Buildings, Johannesburg, and three ordinary lead pencils were stood up on one end on it. Although several severe shocks took place over several months, none of the pencils was overturned until the shock of Sept. 28, when one pencil, which was probably less accurately squared at the end than the others, was upset. This appears to show that the amplitude of the shocks was quite small. The intensity of the most severe of the Johannesburg shocks may be put down as IV or V of the Rossi-Forel scale—"IV feeble; felt by persons in motion, but not generally; disturbance of certain objects. V, moderate, felt by every one; disturbance of furniture, etc., quite general." But the different character of an earthquake and a shock makes a comparison difficult.

The shocks are of sufficient violence to be distinctly felt as a bodily sensation, to awaken the average sleeper, to rattle crockery and windows, and in exceptional cases to dislodge and break crockery. In the more pronounced shocks the physical sensation is that of a thud caused by a heavy weight falling. Sometimes they are accompanied by noises resembling thunder. There does not appear to be any marked difference in intensity of shocks in the southern and northern suburbs; very heavy shocks are felt in the mines themselves.

There is a distinct difference between the local earth tremor, or shock, and an earthquake, both in physical sensation and seismographic record. The continued oscillating movement of an earthquake is almost absent in the case of local shock. The shock is more of a sudden jerk; in the record the pen often jumps along the paper instead of making a continuous trail. The duration of an earthquake is also much longer, the waves commencing small, gradually increasing and then decreasing. Distant earthquakes have been recorded with much larger amplitude than those of the local shocks, yet they have not been locally perceptible. Earth tremors do occur without mining and have been recorded both in parts of the Union of South Africa and in Scotland (at Comrie,

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in Perthshire, where an earthquake house was erected and three or four tremors a year recorded until about 1880). It is not possible, however, to attribute the shocks experienced on the Rand to any natural causes. For one case such as at Comrie there are hundreds where they are traceable to mining operations.

The committee rejects the theories put forward by witnesses that the shocks are due to pumping water in the mines, or seasonal influences, vibration of batteries or distant volcanic influences. No satisfactory evidence can be brought forward for such surmises. The committee finds a sufficient and sole cause in the extensive mining operations, especially along the Central Witwatersrand. This explanation fits all the facts and phenomena.

Two slices of the earth's crust, corresponding to the South Reef and the Main Reef ledges dipping 40°, are removed almost contiguously over large areas. In the cavities thus formed, portions of the solid ground called pillars are left in at intervals. They are anywhere from 10 to 40 ft. in diameter and are supplemented by timber supports or packs built of waste rock, by sandfilling from the surface and by intact areas of unpayable ground. In addition, large blocks of ore, whether payable or unpayable, are left in around the shafts with the object of safeguarding these vital passages against any danger of movement which might close them up or interfere with the regularity of hoisting operations, on which efficient mining so largely depends. Thus the weight of the overlying mass of rock originally distributed over the whole area is thrown on the pillars, on the adjacent unmined ground and on the artificial supports provided. As long as the depth of the reef is small, the weight to be taken up is also small and the supports withstand the strain.

Increasing Weight Thrown On Pillars

If the area excavated is relatively small, the weight of the superincumbent mass is taken up by the surrounding intact reef, the strata overlying bending through to some extent as the ends of a beam. But as the depth increases, the pressure on the pillars left in increases, and this is accentuated by the increased area of the excavations, which become so large that little weight of the superincumbent mass can be taken up by adjacent unmined ground. In proximity to faults and dikes there is no adhesion to surrounding country and the entire weight is thrown on the pillar supports and sometimes onto particular supports. Pillars are strained to a greater extent than they can bear and are crushed. The reefs mined and the quartzites between them and above them for several thousand feet are massive, hard brittle rocks of great resisting power. They are more liable to rupture suddenly than would be soft rocks like shale. The shocks and bursting of pillars are frequently coincident.

The committee deals with the shaft collapses at the Village Main Reef, the Ferreira Deep and similar occurrences at other mines, with reference to the feature observed in connection with the bursting of pillars or the projection of rock from a stope face, with a gust of wind and a noise like blasting. The report says the word "airblast" is misleading and suggests "rockburst" as more accurate and descriptive. The damage done to buildings is insignificant and in many cases is attributable to defective material and workmanship. While shocks in the future may exceed those that have gone before, the violence will not be sufficiently great to justify apprehension of any disastrous effects on buildings, as it is unlikely that the violence of the shocks can increase to such an extent as to be many times more severe than those already felt. Settlement is likely to be gradual, crushing in pillar after pillar as the weight is successively transferred.

It is obviously impracticable to restrict the size of areas to be excavated if containing profitable ore, since it is one of the fundamental principles of economic mining to utilize all payable ore available. The owner has this right unless its exercise becomes a danger to the community. Mining without pillars is impracticable and might result in the pressure being thrown on the stope faces, and severe bursts might take place. To obviate the bursting of drive pillars, the levels may be driven in the foot wall and the reef exposed by a series of crosscut raises. This method would be disadvantageous in mines with only a small percentage of payable rock. Difficulties of finding the zones of profitable ore would be greatly increased, and the method is probably economically inapplicable to this class of mines. Even in more profitable mines, changes in value and percentage of payable ore are sometimes rapid and the running of levels in the foot wall would enhance the difficulty of obtaining data. The method might be applied where there is sufficient uniformity of value. Where drive pillars show a tendency to fracture and burst, they should be made larger until the stope is exhausted and mined as soon as possible thereafter, or should be entirely discarded and replaced by substantial packing. Blocks of unpayable ground left intact are usually very large and thus able to resist practically any pressure. Where the unpayable blocks are small, it would probably be better to remove them if in a pressure area, even at a loss. In the case of future shafts it is suggested that the pillar for any deep-level shaft be never less than 500 ft. in diameter, if situated in a section that is unpayable or largely so. Such an extensive pillar may be unnecessary. The alternative of making the bottom of the vertical shaft well below the reef plane has also been suggested. Deep incline shafts should be placed well in the foot wall. The removal of all pillars and the filling-in with sand is deemed impracticable and uneconomical.

Prevention of Shocks Not a Mining Essential

It is pointed out that although shocks are unpleasant and even alarming, the taking of steps to avoid them does not primarily constitute one of the objects of mining. The underground effects of rockbursts are far more serious than those felt on the surface and should be prevented for this reason. If the prevention of shocks in Johannesburg entailed mining methods that would greatly increase the cost of mining, the small amount of damage and the alarm of the inhabitants would be insufficient grounds on which to base the experiment of such methods. But when the modification of existing practice should result not only in greater safety and economy, but also in diminishing the frequency and severity of the shocks, it may reasonably be expected of the mines that such steps should be taken.

Exportation of Zinc Ore to their Allies and to America is again established by a ministerial order of Apr. 10, according to a telegram from the United States Consul General at Paris, published in "Daily Consular and Trade Reports," Apr. 13, 1916. The original permission to export zinc ore to allied countries and countries of North and South America was granted by decree of Feb. 12, 1915.

Editorials

Pig-Iron Production of the World in 1915

The production of pig iron in the world has been seriously affected during the last two years by the war now raging in Europe. This will be shown by the figures in the accompanying table, nearly all of them from official statistics, which give as closely as possible that production for the last three years. The figures for the United States and Great Britain have been reduced to metric tons for purposes of comparison.

In 1913, which was a year of steady and intensive business activity, the world's production was the largest ever reported, the total approximating 80,000,000 tons. In that year the United States and Germany, the two leading producers, both made their greatest output on record, while Great Britain showed a very large make, although in that country the total had been exceeded two or three times in earlier years. The lesser producers—France, Belgium, Russia, Austria and Canada—all showed good records, and until near the close of the year the prospect was that even these would be exceeded in 1914. Toward the end of the year, however, business began to decrease in activity, and 1914 opened with rather

PIG-IRON PRODUCTION OF THE WORLD IN METRIC TONS

	1913	1914	1915
United States	31,461,610	23,705,458	30,394,872
Germany	19,309,172	14,389,547	11,790,199
Great Britain	10,649,628	9,149,992	8,934,358
Three chief producers	61,420,410	47,244,997	51,119,429
Canada	1,128,967	783,164	928,339
Austria-Hungary	2,369,864	2,020,000	1,960,000
France	5,311,316	5,025,000	4,750,000
Belgium	2,484,690	1,560,000	.....
Italy	426,755	385,340	395,000
Russia	4,548,396	4,261,008	3,696,560
Spain	424,744	435,000	419,000
Sweden	730,300	635,100	767,600
Other countries	550,500	495,000	480,000
Total	79,395,472	62,844,609	64,515,928

a dreary aspect, so that the first half made a total which was below that of 1913 in a marked degree. The opening of the war in August naturally caused a serious fall, and although there was some recovery later, it was slow and the gradual extension of military operations into some of the iron-producing sections still further brought down the total production. The entire year showed a decrease of 17,500,000 tons, as compared with the great total of 1913. The remarkable point about this is that very nearly half the decrease was in the United States, which was not directly affected by the war, although its business conditions were very seriously disturbed by the financial complications arising therefrom.

In 1915 changes in the area directly affected by the war were very considerable, but perhaps not so great as might have been expected. Thus in Belgium, which has always been a very steady producer, though not one of the largest, the production has disappeared for the time. France was quite seriously affected, owing to the German occupation of some of the area from which her furnaces have been accustomed to draw their ore supply. Germany managed to keep up its pig-iron production to about 60% of the normal, and Russia showed a considerable decrease, owing to the desolation of some of her coal and ore fields. The United States, however, showed a notable recovery, the total reaching within about a million tons of the record established in 1913, while Canada also reached very nearly her highest point. The total iron made in 1915 was hardly equal to the demand, and at the close of the year all countries where it was possible to do so were pushing their iron making to the highest point of capacity.

It is to be noted that the increased production in 1915 was practically all in the second half of the year, the first half showing only a small and slow improvement over the depressed conditions of the previous year.

In 1913 the three chief producers—United States, Germany and Great Britain—made 77.4% of the total output of the world. In 1915 they increased their lead somewhat making 79.2% of the total. This gain was entirely due, however, to the high production of the United States, which in 1915 made 47.1% of the world's total, against 39.6% in 1913, this gain in proportional output being chiefly due to the falling back of the German furnaces. So far as the present year has gone, it looks as though there would be a still greater lead in this country.

Under all the conditions the production on the continent of Europe has been kept up remarkably well. Germany has maintained very nearly the output which in ordinary years was required to meet its home trade. Exports, of course, have been cut off almost entirely. So far as we know, the chief difficulty in Germany has been with the supplies of iron ore, but it has been possible to obtain a very considerable quantity of the minette ore used in the Rhine and other districts from within the lines of the German advance. Imports of the higher-grade ore from Spain have been cut off, but it has been possible, we believe, to obtain considerable quantities from Sweden.

The nature of the demand for iron has, of course, changed considerably during the war period. Probably an unusual proportion of the pig iron made has been converted into steel, which has been used for shells and other munitions of war. In the United States a very considerable part of the production has been so used and exported, although the actual quantity so consumed has been somewhat exaggerated in public estimates.

The quantity of material used in this pig-iron production reaches enormous figures. Even the diminished production of 1915 has required the handling of about 129,000,000 tons of iron ore, 65,000,000 tons of coke or coal for blast-furnace fuel, at least 20,000,000 to 25,000,000 tons of coal for power and other purposes around the iron works and about 30,000,000 tons of limestone flux and other material. That all this should have been transported and handled in a year of abnormal demands for other and unusual purposes is a remarkable feature of the situation.

Electrothermic Zinc Smelting

Amidst the great excitement in the zinc industry during the last year, it is surprising that electrothermic smelting has received so little attention. If there were ever a time to develop a new art, we had it last year, when smelting margins were so big that almost any kind of metallurgical misadventure might be risked without much fear of loss. Previous to the outbreak of the war an electric smelting plant at Keokuk, Iowa, was contemplated, but as yet it has not even been begun.

The only places where electrothermic smelting is being conducted, that we know of, are those places in Scandinavia previously reported. Recent information from there is to the effect that electric smelting has been developing on a gradually increased scale at Trolhättan and has now attained an output of over 6,000 metric tons of spelter per annum. The process remains as heretofore—the ore is first smelted in one set of furnaces and the crude spelter thus produced is redistilled in the refining furnaces. The refining of scrap spelter, dross, etc., is also being carried on at Sarpsborg.

For some time past plans have been discussed for increased facilities for smelting, and it has now been decided to secure the necessary water power from the Glomfjord waterfalls, situated in Nordre Helgeland, in Nordland. These falls have been purchased by a company formed for the purpose, and when fully harnessed are calculated to yield 125,000 hp. The works are expected to be completed by 1918, and the hydraulic power obtained will be used for smelting ore.

Plans are being made for an important experiment in electric zinc smelting in Italy. It is manifest therefore that the idea still lives. However, it is rather strange that so little has been done in this direction during a time when the hydrometallurgical-electrometallurgical process has sprung into prominence from almost nothing.

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The Advance of Flotation

Flotation continues to expand. Its use is widening rapidly, and the almost universal spread of experimentation has led to a much broader knowledge of the principles attending its application. It is particularly noteworthy that flotation is developing in spite of the strenuous efforts on the part of those holding process patents to keep the essential facts secret. By sheer merit this system of metallurgy is taking a high place in the estimation of the world's metallurgists. Independent investigators are discovering the facts and making them public through the technical press. With the assistance of the published data, operators can develop systems applicable to their own ores.

Up to this time the theoretical basis of flotation has been shrouded in mystery. The patent holders have added nothing to scientific knowledge of basic facts, and it has remained for independent investigators to develop a practical theory. This work is rapidly rounding into shape and is pointing the way to further improvement. The explanation by G. D. Van Arsdale that appeared in the *Journal* of May 13 goes a long way toward showing that the fog of mystery surrounding flotation is not a real one, but a hypothetical condition induced by popular ignorance upon the subject. By citing a few incontrovertible facts, Mr. Van Arsdale has succeeded in pointing out a rational basis that is simple and easily understood.

It is noteworthy, too, that many authorities agree that some of our pet hallucinations may soon be relegated to oblivion. Mr. Van Arsdale believes we may have, some day, flotation without froth and possibly without oil. Professor Bancroft has pointed out that a perfectly pure oil may not form froth and that the frothing tendency is due to colloids in suspension in the oil. If that is true, then we may have some other frothing agent and may omit the oil for frothing purposes. Since we know that flotation of minerals may occur without oiling the particles, it does not seem at all impossible that the oil may be, in time, eliminated for that purpose also. The outlook is interesting and important. We wait anxiously for the appearance of each step toward a perfected process that will some day be reached.

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Blasting by Use of Liquid Air

Considerable attention has been drawn to statements emanating from German sources that liquid air has been successfully used for blasting, with very much lower cost than from the use of any other form of explosive. The principle depends upon the fact discovered a long time ago that liquid oxygen, 90% pure, in contact with organic matter such as powdered charcoal or with petroleum absorbed in some inert substance, produces a mixture which can be readily detonated with a resultant powerful explosion.

There are so many practical difficulties in the way of using liquid oxygen, or liquid air, for this purpose that it is very doubtful if the method has any place in mining operations except in Germany, where the blockade has prevented the importation of nitrates from Chile, the nitric acid from which is the most important component part of explosives for ordinary mining as well as military purposes.

In using liquid air for blasting, a cartridge is manufactured containing powdered charcoal or whatever organic material is used, held in place by gauze and cardboard, the ends of the cartridge being closed with cork. The liquid oxygen is introduced into the center of this cartridge by means of a tube passing through one of the corks and is distributed through the organic surrounding substance through gauze ports. Vent holes have to be provided so that gaseous oxygen may escape. Electric detonators are used for the explosion.

The liquid oxygen has to be brought to the mine in specially devised containers, and the cartridge has to be loaded at the place where it is to be used and has to be fired immediately; otherwise the liquid oxygen gasifies and the cartridge becomes nonexplosive.

This method of blasting cannot be used in wet holes, because the water would freeze, owing to the action of the liquid air, and furthermore holes of not less than 2 in. diameter have to be used. Under conditions where no other explosives could be or were available, this method might appeal to mining men, but under ordinary conditions it certainly seems to be an unattractive proposition for practical work.

Liquid oxygen is said to be one of the powerful ingredients in the hand grenades used in trench warfare and in the bombs dropped from aëroplanes.

BY THE WAY

We are in receipt of a letter inclosing $10 with the request, "Please send me the full receipt for treating sulphide ores."

Consider the caution of our great Government, says the *Boston News Bureau*. It has placed an experimental order for three Lewis machine guns. Today England has 20,000 machine guns on order in this country; Canada is signed up for several hundred. And Springfield advices declare that for two or three years no Benet-Merciers or Maxim-Vickers have been made at the Springfield arsenal. But this is to be remedied. The Government has bought three machine guns.

Under the heading "A Mecca for Promoters," the New York *Times* says, cheered by the reports of prosperity in the metal trades, with high quotations making it profitable to operate silver, lead and copper mines which had to give up when prices went down, Westerners have been heading for New York in the hope of being able to interest capital in abandoned workings. One concern has been organized especially for the purpose of taking options on gold prospects. An old-time miner, who thought he had retired with a modest fortune, was in the financial district yesterday with a plan for reopening one of his properties, which he says can now be operated at a good profit, and the strange part of it is that he obtained a promise of enough capital to let him try the experiment.

Carrying iron ore in a good year—or a poor one either—is a profitable business. In 1915 the Duluth, Missabe & Northern Ry. earned $9,909,549, of which $8,673,727 was from iron ore. The net income was $5,711,647, and the dividends paid were $3,084,375, or 75% on the capital stock. Even in 1914, which was the poorest year for seven years past, the earnings were sufficient to pay 10% on the stock. The Duluth & Iron Range R.R. in 1915 earned $5,966,931 gross and $2,992,274 net and paid dividends of 50% on the stock. In the poor year 1914 it could only pay 20%. The Duluth & Iron Range has just retired $3,500,000 in 6% second-mortgage bonds, by issuing an equal amount of stock. Both these roads, by the way, are owned by the Steel Corporation. Two years ago they were "ruined" by an order of the State Railroad Commission cutting rates on iron ore from 80 to 60c. per ton.

Sending supplies to an isolated mine by aëroplane is the latest adaptation of aërial transport. Aëroplane service to the Dolly Varden mine in the Alice Arm district of British Columbia prevented a shutdown, threatened by exhaustion of supplies, due to the unusually prolonged winter weather. The aëroplane service to the Dolly Varden is being rendered under contract by the California Aëroplane Co. at a cost of $600 a month and provides, according to the *Spokesman Review* of May 17, for an average of two round trips daily between the company's wharf on Alice Arm, a branch of Observatory Inlet, and the mine which is distant about 14 mi. from tidewater. Supplies to the amount of 600 lb. are to be conveyed to the mine on each trip. The Dolly Varden is a rich silver-lead mine, and it is now proposed that shipments of ore, carefully selected on account of high silver content, may be made by the same method on return trips. With the great development of aviation, aërial transport is destined to be an important aid to the mining industry. In case of "stampedes" to new finds, an aëroplane would give its owner a great advantage over ordinary "hikers," and it seems certain that in a few years supplies will be regularly carried by aëroplanes to many isolated mines. It may seem so to the *Spokesman Review* but it doesn't to us.

May Mining Dividends

Dividends paid in May, 1916, by 34 United States mining companies making public returns amount to $11,108,170, as compared with $1,564,144 paid by 21 companies in May, 1915. Industrial and holding companies allied to mining paid $6,810,747, as compared with $8,335,435 in 1915. Canadian and Mexican companies paid $1,644,627 in May, 1916, and $558,540 in May, 1915.

The totals for the first five months are as follows: Mining companies, $56,737,834, as against $15,410,388 in 1915; metallurgical and holding companies, 1916, $37,041,787 as against $26,731,200 in 1915; Canadian and Mexican companies, 1916, $10,164,020, as against $4,180,364 in 1915.

United States Mining Companies	Situation	Per Share	Total
Alaska Treadwell, g	Alaska	$0.50	$100,000
Algomah, c	Mich.	1.00	70,000
Anaconda, c	Mont.	1.50	3,496,875
Anchor, s	Nev.	.01	5,000
Big Four, Exp	Utah	.05	20,000
Big Run Zinc, z	Mo.	.03	3,000
Bunker Hill Con., g	Calif.	.025	5,000
Bunker Hill & Sullivan, l.s	Idaho	.50	163,500
Caledonia, l.s	Idaho	.03	78,150
Champion, c	Mich.	6.40	640,000
Chief Con., s.g.l	Utah	.05	44,148
Commercial, g	Ore.	.005	8,330
Golden Cycle, g	Colo.	.02	30,000
Granite Gold, g	Alaska	.02	8,600
Hecla, l.s	Idaho	.10	100,000
Homestake, g	S. D.	.65	163,254
Hercules, l.s	Idaho	.20	200,000
Inspiration, c	Ariz.	1.25	903,678
Joplin Ore and Spelter, l.z	Mo.	.055	22,000
Kennefick Zinc, co., z	Mo.	.10	20,000
Kennefick Zinc, pfd.z	Mo.	1.75	8,750
Mary Murphy, g	Colo.	.07	25,900
May Day, g.s.l	Utah	.02	16,000
Miami, c	Ariz.	1.50	1,120,671
National Zinc and Lead, l.z	Mo.	.05	25,000
Nevada Wonder, g.s	Nev.	.10	148,286
New Jersey Zinc, z	N. J.	9.00	3,150,000
South Eureka, g	Calif.	.07	20,998
Success, z	Idaho	.05	75,000
Tamarack & Custer	Idaho	.02	35,530
Wasp No. 2, g	S. D.	.025	12,500
United Verde, c	Ariz.	.75	225,000
Wilbert, l.s	Utah	.01	10,000
Yellow Aster, g	Calif.	.03	3,000
Yellow Pine, z.l.s	Nev.	.15	150,000
Metallurgical and Holding Companies	**Situation**	**Per Share**	**Total**
California Exploration	U. S.	$0.12	$28,139
International Nickel, pfd	U. S.	1.50	133,689
St. Mary's Mineral Land	Mich.	2.00	320,000
U. S. Steel, pfd	U. S.	1.75	6,304,919
Venture Syndicate	U. S.	.10	4,000
White Knob Copper & Dev., pfd.,g	Calif.	.10	20,000
Canadian and Mexican Companies	**Situation**	**Per Share**	**Total**
Amparo, g.s	Mex.	$0.05	$100,000
Chontalpan y Anexas	Mex.	8.75	61,250
Chontalpan y Anexas	Mex.	25.00	(a) 175,000
Granby Cons., c	B. C.	1.50	224,977
Greene Cananea, c	Mex.	2.00	972,418
Hedley, g	B. C.	.50	60,000
Hollinger, g	Ont.	.20	120,000
Lucky Tiger	ex.	.06	42,920
No. Am. Magnesite	Que.	7.00	13,062
Standard Silver-Lead, s.l	B. C.	.025	50,000

(a) Capital retired.

Seven of the United States mining companies were initial dividend payers, namely: Algomah, Big Four, Big Run, Inspiration, Joplin Ore and Spelter, Kenefick Zinc pfd. and Tamarack & Custer.

Military Engineering Lectures

The last of the series of Military Engineering Lectures held at the United Engineering Societies Building in New York was delivered May 22 by Capt. T. S. Robins, Corps of Engineers, U. S. Army. The subject was the landward defense of the Atlantic Coast.

On account of the richness of the prize, any enemy attacking on the Atlantic side would naturally seek to obtain that portion of the country between Boston and Norfolk. Captain Robins outlined the strategic points in the defense of this section and gave figures concerning the length of front required to defend Boston, Philadelphia, etc., and the number of troops required for those various lines, figures so startling and so impressive that it was greatly to be regretted that the attendance at this final lecture was not up to the average heretofore.

For reasons too well known to mention, New York would be the primary object of an invading force, and inasmuch as the food supplies of New York are never sufficient for more than three or four days, the importance of guarding the trunk lines leading into the metropolis is self-evident. The landing points along the coast from which these trunk lines could be attacked by raiding parties were enumerated, and the necessity for troops on the spot and not mobile troops somewhere else, which could be transported only too late to prevent a successful raid, was dilated upon. The National Guard of New York State is generally conceded to be the best type of organized militia in the country and numbers from 10,000 to 14,000 men. It is estimated that in case of impending attack or invasion in this country, it would require this entire force to guard the water-supply system of New York City, coming as it does from the Catskill Mountains, more than 120 miles away, through the series of lakes, tunnels, aqueducts, etc., which constitute one of the famous engineering accomplishments of the era.

Army officers during the past few years have made detailed studies of the methods of defense of this section of the country, and detailed maps have been made showing when semipermanent fortifications, trenches, etc., should be established. These plans are filed away and very carefully guarded. The encouraging fact that they are in existence and that the problems have in a measure been worked out is discounted by the fact that owing to the paucity of officers in the service at present, an entirely inadequate number are familiar with these plans, and there are no men for digging the trenches even if they knew where their location was specified. The new Army Bill, whatever may be its defects and whatever criticism may be leveled at it in detail, does give the country a framework for a more extensive organization by providing for a larger number of officers in the regular service.

The committee on these Military Engineering Lectures, on which are several prominent mining men, has perfected its organization in many ways and will continue its work, although there will be no further lectures until fall. At that time an entire program will be presented to the engineers and further and advanced work taken up. This series of lectures has been a great success in every way, and the army has paid a compliment to the members of the various engineering societies by stating that it is a great comfort to them to know that they have so many capable men on whom to depend for engineering service.

Copper Market of Havre

For some time Havre has ranked as the most important copper market in France, says *Daily Consular and Trade Reports,* Apr. 19, 1916. At the close of 1914 the stocks at Havre amounted to only 2,827 tons, as compared with 5,624 tons at the beginning of the war in August, 1914. By the end of 1915 the stocks had fallen to 1,299 tons, as a result of the demands of consumption and the impracticability of making imports from England.

At the beginning of 1915 almost all the purchases of electrolytic copper held by the Havre traders were resold to contractors in war supplies, and as a result of the large margin between standard copper and electrolytic copper these sales were not followed by a restocking of the market, because the furnishers of war supplies obtained their material directly from the country of origin. It is probable that at the end of the war the market will resume its normal function, which is to serve as intermediary between the producer and the consumer.

Iron and Steel in Sweden

The Swedish Iron Masters' Association reports production of iron and steel in Sweden for three years past as follows, in metric tons:

	1913	1914	1915
Pig iron	730,300	635,100	767,606
Wrought-iron blooms	158,500	113,300	119,200
Converter steel	115,800	93,000	90,400
Openhearth steel	469,400	407,600	498,400
Rolled iron and steel	.....	.....	401,900

The number of works active at the close of 1915 was 101 blast furnaces, 155 puddling hearths, 14 bessemer converters, 60 openhearth furnaces.

Exports for three years past are reported as follows, in metric tons:

	1913	1914	1915
Pig, spiegel, etc.	225,500	179,800	305,100
Puddled blooms and bars	198,200	131,700	187,000
Other finished forms	78,900	71,300	96,800
Total	502,600	382,800	588,900

Scrap is included with pig iron. The exports of iron ore in 1915 were 5,994,000 tons, against 4,681,000 tons in 1914 and 6,440,000 tons in 1913.

Imports in 1915 were 115,900 tons of pig iron and 114,100 tons finished iron and steel—a total of 230,000 tons, against 238,800 tons in 1914 and 247,700 tons in 1913. The decrease from 1914 was chiefly due to smaller trade in rails.

Guarding the Precious Metals

Now that gold is so carefully watched by the British government, the jewelers have been made to understand that the melting of money is regarded as not altogether patriotic, and government prohibition has been threatened, according to *Daily Consular and Trade Reports,* Mar. 28, 1916. Toward the close of last year the government imposed an embargo on platinum and required the jewelers to make returns as to the amount in stock. For the present no more platinum will be allowed to go into consumption.

Tasmania's Mineral Production for 1915 has been officially reported by the Secretary for Mines, as follows, the items being arranged in order of descending value: Blister copper, 7,901 tons; tin ore, 2,599 tons; silver-lead ore, 10,383 tons; gold (fine gold including gold contained in blister copper), 18,547 oz.; coal, 64,536 tons; wolfram, 95 tons; iron pyrites, 12,836 tons; osmiridium, 247 oz.; bismuth, 6 tons; copper, 66 tons.

PERSONALS

P. C. Damman, lately at Aurora, Nev., is now in Chicago.

H. A. Russell, lately at Wallace, Idaho, is now at Joplin, Mo.

John J. Croston, Jr., has gone from Globe, Ariz., to Victor, Colo.

Stanford Leland, lately at Bland, N. M., is now at Mackay, Idaho.

W. R. Thomas, recently at Zacetecas, Mexico, is at Sellwood, Ont.

Daniel Reichel, recently at Berkeley, Calif., has gone to Thane, Alaska.

H. M. Anderson, lately at Redwood City, Calif., is now at Thane, Alaska.

Thomas Morcom, lately at Lynchburg, Va., has gone to Montpelier, Idaho.

J. P. Chadwick, of the Braden Copper Co. in Chile, is at North Waterloo, Maine.

William Braden was in Lima late in May, and will make a stay of some duration in Peru.

Leighton Stewart, recently in Chile for the Andes Exploration Co., is now in New York.

Roman Kozlowski has been appointed director of the Bolivian School of Mines at Oruro.

Thomas McCormac has gone from Pioche, Nev., to the Groom mine at Las Vegas, N. M.

A. J. Anderson, recently at Mogollon, N. M., is now with Moose Mountain, Ltd., at Sellwood, Ont.

B. E. McKechnie, late with the Pennsylvania Steel Co. at Lebanon, Penn., is now at Fierro, N. M.

J. C. Fuller, lately at Copperhill, Tenn., is now with the Cuban Portland Cement Co., at Mariel, Cuba.

F. G. Clapp of the Associated Geological Engineers is conducting geological explorations in Southern Oklahoma.

W. E. Dunkle has succeeded F. R. Van Campen as superintendent of Beatson Copper Co. at Latouche Island, Alaska.

Charles A. Burdick has returned to New York from Virginia where he has been engaged for about a month on examination work.

R. R. Leslie, mine manager of Butters Divisadero Co., Salvador, sailed from New York for London, May 20. He will return in about three weeks.

Samuel C. Thomson, has recently returned to New York from a trip to Alaska and an investigation of mining properties in Tuolumne County, Calif.

Chas. F. Williams, formerly with the Chino Copper Co. at Hurley, N. M., is now mining engineer with the Cananea Consolidated Copper Co. at Chivatero, Mex.

Professor E. J. Saunders, of the department of geology of the University of Washington, will conduct a geological field course from June 19 to July 28 in the Glacier and Yellowstone Parks.

Joseph Struthers who was lately with the Johnson Electric Smelting Co., has become treasurer of the Federal Export Corporation and the Federal Shipping Co., of 111 Broadway, New York.

Frank F. Wells, diamond-mining expert of Johannesburg, South Africa, is stopping in New York at the Hotel Martinique. He will be pleased to meet anyone interested in diamond mining or prospecting.

S. Naganuma has opened an office at room 1042 Equitable Building, 120 Broadway, New York, as representative of Mitsubishi Goshi Kaisha, doing a large mining and ocean shipping business in Japan.

A Party of Capitalists, including the directors of the McIntyre mine, headed by Colonel Hay, made an inspection of the property and other Porcupine, Ont., mines last week, returning to Toronto May 24.

James A. Lannon has succeeded Webster P. Cary as superintendent at the Atlas Mining and Milling Co.'s property, Ouray, Colo. Mr. Cary resigned to take a position with John M. Callow, Salt Lake City, Utah.

L. G. E. Bignell formerly sales manager for the Denver Engineering Works and for the past three years engineer for the Mine and Smelter Supply Co. at El Paso has accepted a position with the Colorado Iron Works at Denver as sales engineer.

Gilbert Rigg, who for many years was at the head of the research department of the New Jersey Zinc Co., and lately resigned that position to take charge of the zinc metallurgical branch of the Associated Broken Hill Smelters, started from New York, May 27, on his way to Australia.

G. H. Cunningham who has been superintendent of construction of the electrolytic zinc plant at Washoe Reduction Works, Anaconda Copper Mining Co., Anaconda, Mont., has been appointed construction engineer in charge of installation of equipment 100-ton electrolytic zinc plant, which the Anaconda is building at Great Falls, Mont.

Frederick J. H. Merrill, from 1899 until 1904 state geologist of New York, from 1905 until 1913 consulting geologist and mining engineer in Mexico, Arizona and California, and since 1913 field assistant of the California State Mining Bureau, has moved to Los Angeles, where he will resume consulting practice in geology and mining engineering.

L. B. Weed, superintendent of the iron mine at Sunrise, Wyo., has been promoted to be general superintendent of all the iron mines and stone quarries operated in Wyoming, Colorado and New Mexico by the Colorado Fuel and Iron Co. His headquarters are at Pueblo. Mr. Weed was succeeded as superintendent at Sunrise by Thomas Tucker, former foreman of the mine.

John Hughes, who for 13 years past has been general agent of the United States Steel Products Co. and for three years past special agent for the United States Steel Corporation, as well, has been made assistant to President Farrell of the Steel Corporation. This change has been brought about by the recent promotion of W. B. Perley, as active head of the new Canadian Steel Corporation.

OBITUARY

W. H. Daniels, of Spokane, Wash., well known as a mine owner and operator in Minnesota and Idaho, was drowned in Cœur d'Alene Lake, Idaho, Apr. 30, by the upsetting of a boat.

Major John W. Eckman died at Pulaski, Va., May 11, aged 74 years. He was born in Pennsylvania, served through the Civil War and soon after settled in Virginia where he became interested in the development of the iron industry. He was for over 30 years general superintendent of the Pulaski Iron Co. He was one of the promoters and a large owner in the sulphuric acid plant at Pulaski.

Cloud C. Conkling, chief civil engineer of the Lackawanna Steel Co., died May 8, aged 53 years. He was born in Rensselaerville, N. Y., spent his boyhood days at Scranton, and was educated in the public schools of that city. He entered the department of civil and mining engineering of the Lackawanna Iron and Steel Co. in 1886, as rodman, continuing with that company, now the Lackawanna Steel Co., in various capacities. He had entire charge, for the first year and a half, of the construction of the company's plant at Buffalo, and was chief engineer of the company up to 1904, at which time he left its direct employ to engage in practice as consulting civil engineer at Buffalo.

SOCIETIES

Portland Cement Association—The Extension Division will conduct at Lewis Institute, Chicago, June 26 to July 1, a short course in concrete for manual training and vocational teachers.

New Mexico School of Mines—At a recent meeting of the board of regents of this school at Socorro, Prof. Fayette A. Jones was unanimously reëlected president. Prof. E. D. Kingman, of Boston, was elected to fill the newly created chair of civil engineering.

University of Illinois—Professor G. A. Goodenough of the Department of Mechanical Engineering, has undertaken an analytical study of the stresses in convex boiler heads; actual experimental work to verify the analytical results will be undertaken by Professor H. F. Moore of the Department of Theoretical and Applied Mechanics. The Babcock & Wilcox Co. has presented a cylindrical drum to be used in the tests. The Department of Mechanical Engineering has just received from the Crane Company of Chicago, Illinois, through its representative, Mr. D. G. Park, an unusually complete and attractive exhibit of the product of this company, including a number of very large valves, steam traps and other power specialties.

University of California—The College of Mining has completely reorganized its curriculum. The students are now allowed to choose between four-year courses for mining engineer, metallurgist, economic geologist or petroleum engineer. This choice is to be made upon the completion of the freshman year, which is the same for all four courses. The petroleum engineering course will include special work in chemistry, invertebrate geology, petroleum mining, drilling and control of oil wells, methods of extracting oil and gas, the economics of the oil industry, and valuation of oil lands; also a new course will be given in petroleum cost accounting. The College of Mining, of which Prof. Andrew C. Lawson is now dean, has an enrollment of 96 students.

INDUSTRIAL NEWS

The offices of Browne & Caine, Inc., are now at 2112 Michigan Ave., Chicago.

A Dominion charter has been granted to Arthur D. Little, Ltd., Montreal, a corporation organized and equipped for the service of Canadian industry and the study and development of Canadian resources. The special facilities of the new corporation will be supplemented by the entire staff organization and equipment of Arthur D. Little, Inc., Boston.

The Traylor Engineering and Manufacturing Co. announces that owing to the increasing demand its present shop capacity will be more than doubled this spring. The improvements already under way consist of the erection of a new machine-shop 76x500 ft., having a balcony 30x400 ft. for small tools, etc.; an addition to the present plate-shop 110x112 ft.; a warehouse 75x188 ft., and four stories high; rearrangement of the trackage system made necessary for handling the greatly increased business.

TRADE CATALOGS

The Wm. Powell Co., Cincinnati, Ohio, Circular. Throttle Valves. Illustrated.

The Richardson-Phenix Co., Milwaukee, Wis. Bulletin No. 5. Oil Filters. Illustrated, 24 pp., 8½x11 in.

Herman A. Holz, 50 Church St., New York, N. Y. Catalog. The Brinell Meter. Illustrated, 10 pp., 9x6 in.

Buffalo Foundry and Machine Co., Buffalo, N. Y. Catalog. Bell Steam Hammers. Illustrated, 34 pp., 8½x11 in.

The A. & F. Brown Co., 79 Barclay St., New York. Catalog. Power Transmission Machinery. Illustrated, 132 pp., 5x8 in.

Western Electric Co., 463 West St., New York. Catalog. Inter-phones and Accessories. Illustrated, 60 pp., 8x10½ in.

Sullivan Machinery Co., Chicago, Ill., Bulletin 70-C. The Sullivan "DR-6" Mounted Hammer Drill. Illustrated, 16 pp., 6x9 in.

May-Nelson Mfg. Co., 1202 F St., Washington, D. C. Bulletin No. 5. Rotary High Vacuum Pumps. Illustrated, 12 pp., 5½x8½ in.

Municipal Engineering and Contracting Co., Railway Exchange, Chicago, Ill. Catalog. Concrete Mixers. Illustrated, 32 pp., 8x9 in.

Armstrong Cork Co., Pittsburgh, Penn. Catalog. Nonpareil High Pressure Covering for Heated Surfaces. Illustrated, 83 pp., 9x6 in.

Taylor-Wharton Iron and Steel Co., High Bridge, N. J. Bulletin No. 113-D. Tisco Manganese Steel Chains, Sprockets and Conveyor Parts. Illustrated, 24 pp., 6x9 in.

Taylor-Wharton Iron and Steel Co., High Bridge, N. J. Bulletin No. 104-A. Tisco Manganese Steel Repair Parts for Gyratory and Jaw Crushers. Illustrated, 16 pp., 6x9 in.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y. Form 9023, Imperial Tie Tamping Outfits. Illustrated, 24 pp. 6x9 in. This bulletin describes a tie tamper made on the principle of a hand hammer drill.

The Locomobile Co. of America, Bridgeport, Conn. Catalog. Riker Worm-Drive Motor Trucks. Illustrated, 48 pp., 8x11 in. Bulletin. "What Our Worm-Drive Motor Trucks Are Doing." Illustrated, 54 pp., 8x11 in.

Sprague Electric Works, 527-531 W. 34th St., New York. Bulletin No. 48,907. Five-hundred Pound Electric Hoists. Illustrated, 8 pp., 8x10½ in. Bulletin No. 49,600. Flexible Steel Armored Conductors, Flexible Steel Conduit, Stamped Steel Boxes, Fittings and Tools. Illustrated, 24 pp., 8x10½ in.

NEW PATENTS

United States patent specifications listed below may be obtained from "The Engineering and Mining Journal" at 25c. each. British patents are supplied at 40c. each.

ALUMINUM—Process of Recovering Metals. Clinton S. Robison, Chicago, Ill., assignor to The Metallic Smelting and Refining Co., Chicago, Ill. (U. S. No. 1,180,435; Apr. 25, 1916.)

CONCENTRATOR—Ore Concentrator and Classifier. Frederick N. Hubbell, San Francisco, Calif., assignor to David R. Carrier, San Francisco, Calif. (U. S. No. 1,184,240; May 23, 1916.)

COPPER REFINING—Process of Refining Copper. Edward C. King, Cananea, Mexico. (U. S. No. 1,183,736; May 16, 1916.)

DESULPHURIZING—Process of Desulphurizing Ores. Howard F. Wierum, Upper Montclair, N. J., assignor to the Sulphur Syndicate, Ltd., London, England. (U. S. No. 1,182,951; May 16, 1916.)

DREDGE METER. Theodore Eder, Sacramento, and Daniel T. Owen, Perkins, Calif. (U. S. No. 1,181,511; May 2, 1916.)

DRILL—Fluid-Pressure-Operating Mechanism. Omar E. Clark, Denver, Colo., assignor to the Denver Rock Drill Manufacturing Co., Denver, Colo. (U. S. No. 1,183,275; May 16, 1916.)

DRILL—Rock Drill. August M. Becker, Toronto, Ont. (U. S. No. 1,183,827; May 16, 1916.)

DRILL—Rock Drill. Omar E. Clark, Denver, Colo., assignor to the Denver Rock Drill Manufacturing Co., Denver, Colo. (U. S. No. 1,183,274; May 16, 1916.)

DRILL CHUCK—Chuck for Percussion Drills. Lewis L. Scott, St. Louis, Mo. (U. S. No. 1,182,934; May 16, 1916.)

DRILLING—Means for Attaching Rock-Drilling Machines to Their Feeding Devices. John Frederick Van Der Velde, Jeppestown, Johannesburg, Transvaal. (U. S. No. 1,181,701; May 2, 1916.)

FLOTATION — Separation of Metallic Sulphides. Leslie Bradford, Broken Hill, N. S. W., Australia. (U. S. No. 1,182,890; May 16, 1916.)

FLUE PRODUCTS—Method of Treating Flue Products. Francis C. Ryan, Hammond, Ind., assignor of one-half to United States Metals Refining Co., Chrome, N. J. (U. S. No. 1,182,320; May 9, 1916.)

GAS—Method of Purifying Gas. Carlton F. Moore, Salt Lake City, Utah, assignor to United States Smelting, Refining and Mining Co. (U. S. No. 1,184,006; May 23, 1916.)

HOISTING—Apparatus for Preventing Overwinding at Collieries and Mines. William Henry Ashton, Wigan, England. (U. S. No. 1,183,057; May 16, 1916.)

LAMP—Mine Lamp. William McKean White and Everton C. Brommer, Indianapolis, Ind., assignors, by mesne assignments, to Electric Service Supplies Co., Philadelphia, Penn. (U. S. No. 1,183,147; May 16, 1916.)

LEAD AND ZINC—Process of Treating Ores. Edward Harrison Snyder, Pioche, Nev. (U. S. No. 1,184,585; May 23, 1916.)

MINE CAR—Warren V. Johnson and John Lee McDowell, Bloomsburg, Penn., assignors to American Car and Foundry Co., New York, N. Y. (U. S. No. 1,183,982; May 23, 1916.)

MINE-CAR WHEEL. Warren V. Johnson, Bloomsburg, Penn., assignor to American Car and Foundry Co., St. Louis, Mo. (U. S. Nos. 1,183,984 and 1,183,985; May 23, 1916.)

MINE-CAR WHEEL (Roller-Bearing). William J. McDonald, Huntington, W. Va., assignor to American Car and Foundry Co., St. Louis, Mo. (U. S. No. 1,183,994; May 23, 1916.)

MINE-CAR WHEELS, Oiler for. Victor Willoughby, Jeffersonville, Ind., assignor to American Car and Foundry Co., St. Louis, Mo. (U. S. No. 1,183,941; May 23, 1916.)

MOTOR. Daniel S. Waugh, Denver, Colo., assignor to Denver Rock Drill Manufacturing Co., Denver, Colo. (U. S. No. 1,183,257; May 16, 1916.)

REFRACTORY ORES — Electrochemical Treatment of Metal-Bearing Material. William Holman James, Johannesburg, Transvaal, South Africa, assignor, by mesne assignments, to New Refractory Ores Ltd., Johannesburg, Transvaal, South Africa. (U. S. No. 1,184,456; May 23, 1916.)

ROASTING—Rabble-Arm for Roasting-Furnaces. Harry H. Stout, New York, N. Y., assignor to General Chemical Co., New York, N. Y. (U. S. No. 1,184,394; May 23, 1916.)

SEPARATOR — Dry Ore Separator. David M. Owings, Canton, and William R. Kinsey, Bartlesville, Okla. (U. S. No. 1,183,226; May 16, 1916.)

SINTERING—Method of Treating Ore. Max McMurray, Cleveland, and Benjamin J. Mullen and Harry Peppel, Leetonia, Ohio; said Mullen and said Peppel assignors to United Iron and Steel Co., Cleveland, Ohio. (U. S. No. 1,183,891; May 23, 1916.)

SLAG-DISINTEGRATING APPARATUS. Lars Larson, Chicago, Ill., assignor of one-fourth to George Paulson, Chicago, Ill. (U. S. No. 1,184,462; May 23, 1916.)

SULPHUR—Process of Recovering Elemental Sulphur from Sulphur Gases. William Francis Lamoreaux, Isabella, Tenn. (U. S. No. 1,182,915; May 16, 1916.)

THORIUM—Recovery of Thorium. Edward D. Campbell and Robert J. Carney, Ann Arbor, Mich. (U. S. No. 1,182,880; May 9, 1916.)

ZINC—Electric Furnace Permitting the Extraction in a State of Purity of Zinc from Its Ores. Eugène Francois Côte and Paul Rambert Pierron, Lyon, France, assignors to Société Anonyme pour l'Electrométallurgie du Zinc, Procédés Côte, et Pierron, Lyon, France. (U. S. No. 1,184,520; May 23, 1916.)

ZINC—Process of Roasting Zinc-Blende. Charles A. H. de Saulles, New York, N. Y. (U. S. No. 1,183,172; May 16, 1916.)

Editorial Correspondence

SAN FRANCISCO—May 22

Union Consolidated Made a New Record of ore extraction on the Comstock which is a reminder of the early-day prosperity of the North End mines. The extraction of ore for the week ended May 20 reached 484 tons, the gross value of which was aproximately $17,000, or an average of $35.40. The best ore came from No. 4 stope on the 2,400 level which produced nearly $13,000, the ore averaging about $45 per ton. No. 5 stope on the same level averaged $33 per ton. An improvement was also noted in the ore from No. 1 stope on the 2,500 level. The north drift on the 2,700 level continues to show vein material of low assay and the Mexican north and south drifts on the 2,500 level are in a promising formation. The 484 tons produced by the Union were treated at the Mexican mill. The Sierra Nevada, Ophir and Con Virginia are advancing drifts and crosscuts in promising vein matter and the Union shaft has been repaired and placed in good condition to the 465-ft. point below the 2,000 station. In the Gold Hill region the Crown Point-Belcher and Jacket saved 594 cars and the Jacket mill received 858 tons.

The Wilshire Bishop Creek Co., operating in Inyo County, has legal complications added to its other troubles. The company was incorporated under the laws of Arizona and has its principal office in Bishop, Calif., which is the nearest post office to the mine. The capital stock is divided into 5,000,000 shares of a par value of $5 per share, which is a rather high capitalization. Andrew Heide, a stockholder, has petitioned the court at Los Angeles for a writ of mandate directed against Gaylord Wilshire, president, and Mrs. Mary Wilshire, vice-president, to compel an exposition of the books and to secure the names and addresses of the stockholders. Heide alleges that there are approximately 6,000 shareholders in the United States and other countries and that Wilshire is in control of the corporation, owning the majority of the shares. It is alleged there has been no meeting of the stockholders since the one held in London in 1913 when there was no quorum present; that since November, 1913, no financial statement has been furnished or has been accessible to the stockholders; that an assessment of 5c. was levied on the capital stock to pay certain indebtedness and that this indebtedness was less than the amount secured. Mr. Wilshire is reported to have stated that the attorneys have been offered every facility for examining the financial books and accounts of the company and invited to put an expert to such an examination. Wilshire claims that the real purpose of the investigation is to secure a list of the stockholders for the purpose of inducing the stockholders to pay to the investigators a fee of 2c. per share for adjusting the affairs of the company and winding up the corporation.

VALDEZ, ALASKA—May 16

In The Valdez and Port Wells Districts, the outlook for the coming year is encouraging. The wildcatting methods of old seem to have been eliminated, and properties will be worked on a more sensible basis, with installations of equipment which some of the mines now justify. The two leading mines of these districts—the Granite mine at Port Wells, and the Ramsay Rutherford mine near Valdez—will operate as heretofore. The Granite has been entirely paid for and is being run at a profit under the superintendency of W. R. Millard. The mine is well equipped with air compressor, drills, milling and other machinery, and holds the position of the leading mine in the Port Wells district. The Ramsay Rutherford mine has always been operated at a profit, but, owing to glacial conditions, is not operated during the fall and winter.

DENVER—May 26

Deep Exploration of the Camp Bird Mine is being conducted by a corporation organized under the name of the Camp Bird Tunnel Mining and Transportation Co. The measurable reserves of the Camp Bird mine, according to the manager's report for the first quarter of 1916, are reduced to the negligible quantity of about 1,200 tons, and there is little prospect of developing any more of consequence in Camp Bird vein until after the 2-mi. tunnel, now being driven, shall have reached the vein Regarding general developments in the mine, he said that work on the ninth level had disclosed a character of vein and rich ore showing along the floor fully sufficient to warrant exploration at greater depth. Further, this stretch of ground represents but about 10% of a mineralized vein, the remainder of which can only be worked with any degree of safety, if indeed at all, through a drainage tunnel; and while it is possible the ground immediately under ninth level might be explored by sinking shaft No. 3, the other 90% of vein would still remain but partly developed, and for this reason it was decided not to sink a shaft that would only partially develop, but to drive a drainage tunnel, the completion of which will leave all of the mineralized stretch, 4,000 ft. in length, accessible for exploration at minimum expense. The drainage tunnel, with its portal at grade delivery of the mill, will require a drive 10,700 ft. long to reach the vein. At the end of the first quarter, the tunnel had been advanced 329 ft. and the work is being vigorously prosecuted.

The Drop in the Tungsten Market has created a decided commotion in this state particularly in the Boulder-Gilpin field in which there has been such feverish activity this last winter and spring. The miners and promoters, being unwilling or unable to believe that the drop in prices has been due to the increased production, both domestic and foreign, are organizing with the view of controlling the market. A largely attended meeting was held at Nederland, speeches were made by several men who have attained some prominence in the district, and a committee of 15 was appointed to represent the numerous small camps in the district. It was advocated that the producers could control the price by concerted action. Such a suggestion is, to the unprejudiced person, puerile. The situation with regard to the sale of tungsten ores and concentrates in this field is difficult to analyze. It is stated on good authority that the only miners who are able to dispose of their productions are the lessees from the three dominating companies, owning much of the valuable territory in the belt, who are under binding contracts to purchase, on the $60 schedule, all the ores offered by the lessees. Contradicting this statement it is stated that certain "independent" miners have actually sold their ores the past week on the $60 schedule. Another statement is that such sales were made by the independents but that they were made at prices around $40@45. Many promoters of new companies are endeavoring to dissipate the gloom and to substitute assurance of an early restitution of high prices for tungsten-mine products. Meanwhile, the law of supply and demand and not a combination of consumers is dominating the situation.

BUTTE—May 25

The Specter of Labor Trouble looms large in Butte again, and if some of the minor unions carry out their threats to try and enforce a demand for increases in wages, a shutdown may result again. The miners have an agreement with the mining companies by which they are paid on a sliding scale, according to the price of copper, but in the last year they have been raised twice voluntarily by the mining companies because the price of copper has gone higher than was anticipated when the agreement was made. Every time that the miners have received added compensation for their hazardous labor, nearly every other union in the district demanded raises or made new and exacting rules for the government of their employment. Landlords instantly raised rents on rooming houses and the rooming-house keepers in turn raised rents on rooms for miners, so that in the end of the round the miner was worse off after his raise in wages than he was before. Now, several more unions, more or less directly connected with the mining industry, serve notice on employers that after June 1 the common laborer must be paid $4 per day, and the teamsters must have a 50c. increase, and hod-carriers must have $6 per day! The employers' association, which includes in its membership Anaconda, North Butte, Butte & Superior, East Butte and the Clark interests, in addition to a large majority of the important business houses of Butte, have issued notice to all members that the raises will not be granted. The employers say the demands cannot be granted without serious future consequences, and that to grant them would be unfair to the miners. Heretofore it has been difficult to hold merchants in line because they have been afraid of the unions, and the result has been a very unjust rate or scale of wages enforced by different unions. Now, however, all the mining companies, railroads and other

large employers of labor are well united, and if the labor unions attempt to enforce their demands an interesting fight may be looked for, and the public, as usual, is prepared to get the worst of it.

SALT LAKE CITY—May 25

Potash Has Been Found near Cedar City and Parowan, in Iron County, in the southwestern part of the state. The material occurs in light-colored sandstone beds about 400 ft. thick lying between two beds of conglomerate. The material is partly in the form of a potash alum; salts of soda, magnesia, etc., are probably present. On some of the protected faces or cliffs there has been an accumulation of the potash and other salts, but the grade of any particular bed and of the large mass of sandstone through which the material occurs remains to be determined. A large number of claims have been staked, and recorded at Parowan, the county seat. This section is reached from Lund, a station on the San Pedro, Los Angeles & Salt Lake R.R., there being an auto stage to Cedar City, 34 mi. distant.

ELY, NEV.—May 23

The Snake Range Tungsten District continues active. At Tungsten, the United States Tungsten Corporation continues to uncover new veins. The company has in its employ a very efficient prospector in the person of A. R. Ross, who is a sort of a "free lance" employee, going whither he will over the property, following up float to its sources and opening new veins; this work has been of much importance in determining the resources of the property. The mill is running steadily and turning out a good quantity of concentrates and general conditions in the camp are excellent. On the west slope of the Snake Range, the Consolidated Tungsten Co. is developing the Big Four vein at several points, and the Gem vein on the opposite side of Williams Creek. Out on the hillside, in the open air, a convenient distance above the bed of the creek, there is being assembled a crusher, 5-stamp mill and Wilfley table, all on log foundations. The mill will be run by steam engine and will be housed later. A storehouse, however, has been erected for the concentrates. One of the largest natural exposures of tungsten ore is on the Kirkeby & Lundgren property on the south side of the creek above the Consolidated mine. The vein is exposed for a height of 80 ft. on the 100-ft. cliff wall, it is 6 to 10 ft. wide and contains a high-grade streak 6 to 8 in. wide.

MORENCI, ARIZ.—May 25

The "Labor Forward Movement" received further agitation in the Clifton-Morenci-Metcalf district on May 22, 23 and 24. There was much speech-making, marching and dancing. The color was conspicuously Mexican, the Italians and sundry other nationalities, including Americans, all of which make up about 30% of the workers in the district, participated but scantily in the festivities. The event was the culminating effort in a vigorous campaign to make these 100% union camps; after this everybody is supposed to have a card. As the leader promised at the beginning of the movement that all workers would have to join or get out, just what will happen when they learn there are a good many yet out of the fold is interestingly speculative. There is no end to which Moyer's delegates will not go to gain their object. When, after the militia was called to the border, the mining companies issued rifles to American employees as a measure of preparedness against a possible uprising of Villa sympathizers (there are lots of Villa sympathizers here), the agitators promptly told the Mexicans that the Gringos were being armed to combat offensively the union movement. The mining companies have issued a "Blue Book," containing all the agreements and conclusions between the managers and the grievance committee to date. Among other things and in addition to the raise in wages, the managers promise to keep the peace and preserve the law and to allow their employees to spend their wages where and for whatsoever they choose.

PHOENIX, ARIZ.—May 24

The Magma Copper Co. at Superior has lately secured about all the proven ground near the camp, paralleling the dike that seems to mark the valuable area and starting back beyond the old Silver King, at the head of the Stoneman grade. Magma began with two claims of the old Silver Queen; later it took on long lease a few claims from the Queen Copper Co., on which the Magma concentrator was built. Then followed the acquisition of the rest of the Queen Copper ground, despite protest of Queen stockholders. To the eastward, the claims of the Lake Superior & Arizona company have been taken over by a group of Magma men, who will start operations soon. The L. S. & A. workings are filled with water from the nearby Queen Creek, and it is probable a large pumping plant will be one of the first requisites. The great dike referred to stretches away toward the east, with a long line of prospects paralleling it and the auto road to Ray. The Ray copper deposits, however, are of such different sort that no connection appears probable between them and those of the Superior district.

Many Miners Have Enlisted in the "Arizona Volunteers," following the departure of the militia for border-patrol duty. A large crowd attended a preparedness rally at Globe on May 22. Capt. R. R. Knotts, who is in charge of the work of enlistment in that district, announced that the mine managers were coöperating heartily in the movement. He said that Mr. Beckett, of the Old Dominion, agreed to insure the reëmployment of any man who has been working at the mine for 30 days, who enlists in the volunteers; he also agreed to pay any married recruit from his working force one month's pay and any unmarried man 15 days' pay. Mr. Gottsberger, manager of the Miami Copper Co., also agreed to reëmploy any of his men who join the volunteers and to aid the work with a monetary consideration. Mr. Mills, manager of the Inspiration Consolidated Copper Co., is away at present, but the captain said he felt sure that upon his return Mr. Mills would take a similar stand. To date of the meeting, the enlistments reported were: Bisbee, 25; Globe, 10; Phœnix, 29; Tucson, 22; Yuma, 34; Snowflake, 21; Prescott, 23; Mesa, 7; Tempe, 13.

EL PASO, TEX.—May 25

The First Return of Mining Men to Chihuahua since the exodus of Americans from the country, immediately after the Santa Ysabel massacre, has just taken place. On May 23 A. J. McQuatters, president of the Alvarado Mining and Milling Co., accompanied by about 30 mining men, left Juarez over the Mexican Central R.R. for Parral. A heavy shipment of supplies preceded the party to Chihuahua a few days ago. It is understood the supplies will be taken on to Parral and that the Alvarado company's mines will resume operations at once.

ISHPEMING, MICH.—May 26

Operators of Ore Boats on the Great Lakes are complaining of difficulty in maintaining their crews intact, with the result that there have been frequent delays at lower-lake ports and at the head of the lakes. A number of the freighters, loading iron ore at Duluth and Two Harbors this spring, have been held up for hours because they did not have sufficient men. According to the new seamen's law a boat captain may not leave port now unless he has a full crew, and many complain that the new law is working a hardship on them. The men who are leaving the boats at the head of the lakes are attracted by the high wages being paid on shore in that section and many are going to the mines on the Mesabi range. There is not any shortage of labor at the mines as yet as many miners have returned to the district during recent months. Men who left for other mining districts have come back because they prefer to work in the Lake Superior district, although the wages for miners are higher in many other camps.

JOPLIN—May 27

State Mine Inspector L. I. Burch, who has had immediate supervision of the Joplin camp for the last three years, has sent his resignation to Governor Major and will become superintendent for the Roscoe Conklin interests in this district, represented by Jesse Briegle. Mr. Burch has been a consistent worker for "safety first" in mining, and has helped materially in bringing about better conditions for the miners of the district. His successor has not been appointed.

Fire Destroyed Two Mills during the past week. The Wallower-Cumberland plant at Prosperity took fire, supposedly from defective electric wiring, and was a total loss despite good fire-fighting equipment. This was one of the steadiest producers in sheet-ground field. Origin of a fire that completely destroyed the Duquesne mill southwest of Joplin is unknown. There were 12 miners underground whom it was imposible to bring up at the mill shaft after the blaze was discovered but they were rescued through a field shaft that had long been unused. Mattes Brothers, owners of this property, estimate their loss at $60,000. F. C. Wallower, owner of the Cumberland, is considering plans for rebuilding. He has three other mills in this district.

TORONTO—May 25

Spectacular Samples of ore showing free gold, taken from a claim 8 mi. from Dryden on the Canadian Pacific Ry. in northern Ontario are on exhibition here. The discovery was made by Ernest G. Rognon, formerly of the Nome gold camp, and work up to the present has disclosed a vein 2 ft. wide with visible gold throughout. A test shaft has been sunk 23 ft. and high-grade ore to the value of $8,000 extracted. An assay of 1½ tons is stated to show $99 to the ton. Frank Loring, of Toronto, and R. T. Cornell, of New York, have examined the property and reported favorably as to the richness of the showings.

The Mining News

ALASKA

ANTIMONY MINING is so active that Tanana Valley Ry. will run two trains daily to Chena. About 1,000 tons should be ready for first boats.

GIDEON & QUIRK, operating on "No. 11 below" on Dome Creek, in the Fairbanks district, encountered rich gravel in hole 130 ft. deep; heretofore practically nothing found on claims Nos. 8, 9 and 10 below discovery, though Dome Creek has produced over $7,000,000.

ARIZONA

Gila County

JOHN FULLER of Young, struck 4-in. streak of high-grade gold ore in claims on Spring Creek.

GLOBE-MIAMI DISTRICT shipped in April 8,389 tons copper bullion and 15,112 tons copper ore; of the ore, 7,791 tons were from Globe and 7,341 tons from Miami.

RAY (Ray)—A 7,500-hp. steam turbine is being added to generating plant; important changes being made in concentrator at Hayden; installing machinery to dry concentrates and facilitate handling.

Mohave County

GOLD ROAD (Goldroad)—Winze now nearing 1,400 ft. will be sunk to 1,500 ft. before crosscutting.

WALLAPAI PRESCIOUS METALS (Golconda)—Taken over by W. A. Eaton, of Duluth, Minn.; development to begin immediately; hoist, compressor and drills to be installed.

WILLIAMS TUNGSTEN (Yucca)—F. M. Townsend, of Los Angeles, is head of company, which has acquired these tungsten mines in Aquarius range, 12 mi. from Yucca; recently shipped 4,400 lb., high-grade ore.

Pima County

YUMA (Tucson)—Has just shipped 110,000 lb. molybdenum ore to New York, reported valuation, $17,444.

SOUTH CORNELIA COPPER MINING CO. (Ajo) — Incorporated to develop 10 claims, 3 mi. south of the New Cornelia; E. Sundstrom, manager.

Pinal County

SILVER KING (Silverking)—Reported New York company will reopen famous Silver King mine, idle 30 years.

CHRISTMAS (Christmas)—Will begin sending 250 tons daily to the Hayden smeltery as soon as sampling mill there is reconstructed.

Yavapai County

CUSTOM SMELTING PLANT may be erected at Prescott by English capital represented by George G. Lemons, of London.. Local business men asked to donate site and buy $50,000 stock, to be paid for, after $500,000 has been expended in construction.

VESUVIUS (Zonia)—An 18-in. streak of free gold ore opened.

MONTEZUMA (Prescott)—Will soon be treating 40 tons a day; small flotation plant ordered.

SHILL GOLD MINING (Humboldt)—Will resume operation in near future; John P. Kelly in charge.

BOSTON & JEROME COPPER CO. (Jerome)—New incorporation to develop 200 acres in Verde district.

EUREKA (Wickenburg)—Sold to Boston investors by J. Zeisiger, of Cincinnati; have $200,000 in development fund.

WAKOTA (Congress)—A 10-stamp mill to be installed; shaft now down 1,380 ft.; formerly known as Coronado mine.

FORD, GENUNG AND GARCIA (Wickenburg)—Group of manganese claims sold to California men; initial shipment made.

MONTE CRISTO (Wickenburg)—Will develop thoroughly before shipping; 20 men employed. E. W. Thayer, of Phœnix, owner.

BLACK COPPER CHIEF (Prescott)—This mine in Black Hills will be unwatered and worked, according to J. M. Sullivan, president.

CINNABAR (Copper Basin)—New York syndicate acquired cinnabar claims, in Copper Basin, owned by Messrs. John Ross, McNary, Roberts, Ebel and Hall. Purchase price, $75,000.

JEROME-VERDE (Jerome)—Sulphide ore running 3½% Cu struck in tunnel on 1,400-ft. level, being driven on contract by United Verde Extension; dimensions of orebody not yet determined.

JEROME-PORTLAND COPPER MINING (Jerome)—New company to develop Brookshire group of 22 claims, adjoining the Green Monster and Equator in vicinity of Copper Chief. John M. Sullivan and George Brookshire, organizers.

STODDARD MINES (Stoddard)—Machinery for 100-ton flotation mill on Agua Fria river, arrived at Mayer; will be freighted out, 5 mi., when road under construction is completed; will treat ores of Stoddard Mines Co. and Copper Queen Gold Mining Co.; Rush M. Hess, superintendent.

ARKANSAS

Sevier County

AMERICAN STAR ANTIMONY CO. (Gillham)—Five openings, deepest 225 ft., now being worked, mainly by lessees; ore being treated by company; J. G. Battelle, Columbus, Ohio, president.

CALIFORNIA

Amador County

WILLARD (Magalia)—This 100-acre placer taken over by S. D. Mesmith and W. E. Young, of San Diego. The Willard was famous in 1856 for finding of a $10,000 nugget; idle 40 yr. Channel will be opened by tunneling.

NORTH STAR (Silver Creek)—Reported that this property, and the Boyson, South Keystone and McIntire claims between Sutter Creek and Amador City, adjoining the Keystone, will be developed by Tacoma men through the 1,000-ft. shaft. Charles Colpe, general manager.

AMADOR STAR (Plymouth)—Installation of electrical machinery completed and unwatering of shafts begun preparatory to deeper sinking. Mine formerly worked in connection with old Bay State. B. C. Clark, superintendent; formerly manager of the Lightner mine at Angels. Reported that E. A. Stent and others are behind this enterprise.

Eldorado County

CARLOAD OF CHROME ORE, the first of recent production in this county, shipped from Folsom recently; hauled by motor truck from Salmon Falls to railroad. Deposit near Latrobe purchased by San Francisco men; 2,000 tons to be mined and shipped. Chrome deposit on the Steele ranch near Pilot Hill, located by J. J. Smith and others, also sold to San Francisco men, will be developed.

YELLOW JACKET (Placerville)—Development started, under option, by A. Bebie, of Denver. Mine owned by Supervisor Creighton.

PACIFIC PORTLAND CEMENT CO. (Auburn)—The 600-ft. tunnel will be extended to 1,200-ft. point in Mountain quarry on Middle American River. Property opened from surface by two gloryholes and a third will be started.

Glenn County

CHROME (Fruto)—Carter-Quigg, of Wilmington, Del., operating chrome mines in foothills of Coast Range in the western part of county; 16 men employed. Ore hauled under contract by team distance of 3 mi. to bins; to be reloaded, without handling, into motor trucks that haul the ore 16 mi. to trestle bins at railroad.

Inyo County

ZINC DISCOVERY reported about 2½ mi. from the new camp of Tungsten City. Eleven claims located.

MOLYBDENUM found on north fork of Pine Creek above Round Valley. Vaughn, Sproul and Beaugard, of Bishop, have some fair specimens of the ore.

TUNGSTEN discovered by Spear Bros. on their copper property in Ubehebe district; have delivered about 200 lb. of good-grade scheelite ore at Lone Pine.

Kern County

CALHOUN (Randsburg)—Both gold and tungsten found by George Calhoun in this placer claim in Stringer district.

YELLOW ASTER (Randsburg)—At annual meeting, May 16, Ancker-Mooers-Burcham faction voted 75% of stock electing directors as follows: Albert Ancker, president; E. D. Mooers, vice-president; W. J. Cotton, 2d vice-president and managing director; Dr. R. L. Burcham, secretary; E. L. Kenney, R. A. Dallugga and C. C. A. M. de Pauw.

Nevada County

COPPER PROSPECTS at Spenceville, North San Juan, Sweetland and other nearby camps being developed; Queen Regent Merger Co. operating small furnace at Spenceville.

ELSIE A. (Nevada City)—Optioned by Thomas Nolan to Eastern men.

CHAMPION (Nevada City)—Reported that a rich shoot of ore has been opened; no particulars are available.

PITTSBURGH (Nevada City)—Mine has passed from control of the Weissbein family to Bert Schiessinger, of San Francisco; development resumed.

GOLDEN CENTER (Grass Valley)—Installation of cyanide plant begun; mill running on good ore and installation of second unit of 10 stamps contemplated.

CASSIDY MINES CO. (Grass Valley)—New corporation to develop Cassidy and Linden claims, parallel to the Empire. M. Walters, president; A. Harvey Wright, secretary.

UNION HILL (Grass Valley)—E. L. Oliver, F. W. McNear and others of San Francisco, believed to be interested in option on this property and that Errol McBoyle will be manager. Shaft will be deepened to 1,200 ft. Mine is equipped with 20-stamp mill and other machinery.

GRASS VALLEY CONSOLIDATED GOLD MINES (Grass Valley)—Permitted by Corporation Commission to issue 225,000 shares of stock to C. E. Weeks in exchange for option on Allison Ranch mine and the Sullivan-Donovan, in south end of Grass Valley district; purchase price of Allison Ranch $25,000 and Sullivan-Donovan $19,900. Old workings will be unwatered and development undertaken.

San Bernardino County

MOJAVE TUNGSTEN CO. (Tungsten)—Working wide vein on 150-ft. level. New 20-ton mill started.

CATHEDRAL COPPER CO. (Daggett)—Two carloads high-grade gold-copper ore ready for shipment: Drift at 100-ft. level in 30 ft. on ore. Newton Evans, manager.

STANDARD MILL & MINING CO. (Atolia)—New crusher and sampling works nearing completion on Atolia-Randsburg road, where water will be available from town of Atolia. Wright & Deane, owners.

COLORADO

Boulder County

BOULDER & WESTERN R.R. may be extended from Boulder to Nederland, if citizens of Boulder will raise one-half capital needed.

EAGLE ROCK (Nederland)—Mill capacity will be increased to 100 tons per day.

ROSS & FOLEY (Nederland)—Have decided to open their 20-acre tract to lessees; electric power from Colorado Power Co. available.

RAMBLER (Nederland)—A 12-in. vein assaying 12% tungsten opened in trenching by sub-lessees. Stated vein has been exposed for 400 ft. Ground owned by Wolf Tongue Mining Co.

Chaffee County

ONYX DEPOSIT discovered in Katmundoo Park, nine miles north of Salida. Quarry may be opened.

Clear Creek and Gilpin Counties

STANDARD (Freeland)—Contract awarded Julius Pardi to advance main tunnel 400 ft. and sink winze 110 ft.

FIFTY GOLD MINES CO. (Black Hawk)—Purchase by Cripple Creek men contemplated; examination made.

LITTLE GIANT (Lawson)—Company plans 50-ton mill; estimated 75,000 tons of ore. Property opened by Commodore and Tabor tunnels; machine drills in operation in both openings. St. James adit advanced 800 ft.; breast now under old shaft; raise will connect with bottom of shaft. Ore opened in adit.

ONONDAGA MINES CO. (Georgetown)—Has control of Doric tunnel and plans power plant at portal. Tunnel will be advanced and crosscut will be driven westward to connect with east heading driven on the Ruler vein from Capital tunnel. Contract awarded J. L. Claypool, of Idaho Springs, to advanced Ruler drift, 500 ft.

Dolores County

BUCKHORN (Rico)—Reported 17-in. vein, assaying $26 in gold, opened in this Newman Hill property.

La Plata County

MINING IN CALIFORNIA DISTRICT will be resumed by May Day, Idaho and Tinbroeck mines. Reported that Columbia mine, owned by James Doyle, which has been operating all winter, will build flotation plant.

Mineral County

COMMODORE (Creede)—Work has been resumed.

BACHELOR (Creede)—New mill under construction.

DEL MONTE-CHANCE (Creede)—Surface water giving much trouble. Shipments will be increased soon.

PARK-REGENT (Creede)—Vein of good-grade ore, 7 to 10 ft. wide, opened recently in northern end of property from Nelson tunnel.

CREEDE UNITED (Creede)—Mill operating steadily, treating 2,000 tons per month; shipments 8 cars lead and 1 zinc concentrates. Production will be increased.

HUMPHREYS MILL (Creede)—Flotation process installed. Mill treats ore from Bachelor, Commodore, Last Chance, New York, Amethyst, Happy Thought and Park-Regent mines. Ore transported through Nelson tunnel, 3 mi. in length.

Park County

LONDON (Alma)—Contract let to drive south main tunnel 550 ft. to cut large oreshoot opened in other workings. Planned to drive second tunnel, farther down mountain; tunnel also to be used for transportation with electric haulage. Lessees on London mine producing good-grade ore. Snow roads have broken, necessitating suspension of shipping for short time.

Summit County

TAILINGS DUMP of Excelsior mill purchased by Denver men, and will be retreated for zinc.

MECCA BARS (Breckenridge)—Hydraulic mining will soon be resumed here.

EUREKA (Breckenridge)—Tunnel will be driven to cut at depth oreshoot opened in shaft.

HAMILTON (Breckenridge)—Work will be resumed in near future and mill will be enlarged.

RILLA (Breckenridge)—Crosscut tunnel being driven into North Star Mountain. A. C. Howard, superintendent.

LITTLE GOLD PAN (Breckenridge)—New mill ready. Shoot of good-grade oré opened in tunnel driven from mill level.

WELLINGTON MINES CO. (Breckenridge)—Option secured on Sallie Barber, across gulch; shaft will be unwatered to examine.

JESSIE (Breckenridge)—Electric power will be installed in mill, displacing steam power. During April, in spite of coal shortage, 1,000 tons were mined and milled.

IDAHO

Shoshone County

NELLIE (Osburn)—C. E. Benedict bonded this old property and will sink shaft 100 ft. farther. Lessee and Silverado company considering building joint mill. Ore is gray copper with high silver.

BIG CREEK (Kellogg)—Leaser on upper part of mine has shipped seven carloads of 71- to 107-oz. silver ore within last few months; company will drive crosscut 500 ft. below leased ground.

TUSCUMBIA (Wallace)—Idora mill, on Beaver Creek, which with this mine is under lease to Ehrenberg & Nelson, is now running; concentrates hauled 10 mi. to railroad at Prichard. Ore contains zinc and lead. Improvements in mill during winter resulted in higher zinc recovery.

MARSH (Burke)—Break in power service stopped pump on 900 level for 3 hr. 20 min., water rose and put pumping motor out of service. Motor raised, but pump is under water. Two smaller pumps checking flow of water and it is expected to get another pump in service before water reaches 700 level.

CONSTITUTION (Kellogg)—Shaft sunk 200 ft. on vein; at 100 ft., drifts run east and west 50 ft.; west drift in zinc ore of shipping grade its full width and east drift for about 30 ft., from which point ore is of milling grade. At 200 level, ore contains more lead. Now hauling ore 10 mi. to railroad at mouth of Pine Creek. Plan 150-ton mill.

UNION (Burke)—Leasers opened 2 ft. shipping galena and 6 in. zinc ore in crosscut from Oreano tunnel, cutting 12-ft. vein at 450 ft.; oreshoots on opposite walls; mixed milling ore between. Leasers will extend old Hidden Treasure tunnel, which was run 4,000 ft. many years ago into Union ground, and should cut vein in about 1,000 ft. at depth of 1,200 ft.

RAY-JEFFERSON (Wallace)—New 250-ton mill on Beaver Creek to be completed July 15; some machinery on ground; building almost ready. Gravity tramway 1,400 ft. long will convey ore from upper workings, where oreshoots in three veins opened from 100 to 400 ft. in length. Ore also opened on Carlisle vein near mill. Expect railroad up Beaver Creek this summer; distance about 10 mi.

MICHIGAN

Copper

ONONDAGA (Houghton)—Developing with one drill on Sec. 34.

LAKE (Lake Mine)—Shipping about 300 tons of rock, averaging about 28 lb. Increasing working force.

WYANDOT (Houghton)—Over 3,000 tons now accumulated in stockpile preparatory to test run in Winona mill.

MASS (Mass)—Increasing underground development, though many other mines are neglecting this to obtain maximum present production.

QUINCY (Hancock)—Following success of sand-filling at Copper Range properties, this company will use mill tailings for same purpose.

NORWICH (Ontonagon)—This property, comprising 1,200 acres, has been acquired by a syndicate, including James MacNaughton, Fred Smith, L. L. Hubbard and others, and will be drilled.

ISLE ROYALE (Houghton)—Shipping about 3,000 tons daily, 2,000 being handled in company mill. Most of ore coming from shafts Nos. 4, 5 and 6; Nos. 1 and 7 will be ready soon.

MINNESOTA

Cuyuna Range

FERRO (Manganese)—Shipping about 500 tons per week of manganiferous ore. Car recently shipped to Chciago assayed 27.94% Fe, 0.042 P, 24.10% Mn and 15.94% SiO_2, value about $9 per ton at mine.

Mesabi Range

SELLERS (Hibbing)—Four shovels now operating two shifts; removing ore and some surface material.

BRUNT (Mountain Iron)—Ore being removed from openpit and dried in ore dryer, the only one now in use on Mesabi range; capacity, 2,000 tons daily.

SILVER (Virginia)—Ore being removed with one shovel and two locomotives from stockpile; air compressor recently installed at mine.

WANLESS (Buhl)—Creek which runs over part of underground workings now being diverted by hand ditching; new generator set not yet received.

KERR (Hibbing)—Two shovels are stripping, mainly cleanup work. Mine will be ready to ship as soon as track facilities are provided.

HANNA A. (Mountain Iron)—This openpit, first opened up in 1909, has been idle for two years; will reopen this week. A Model 35 revolving Bucyrus shovel has been purchased.

MISSOURI-ARKANSAS

Joplin District

ORONOGO MUTUAL CO. (Oronogo)—Dewatered Hockaday shaft and will operate mill.

WEST VIRGINIA (Galena)—Enlarged mill on McElroy land, south of Galena; will reopen Margaret mine.

WADE (Joplin)—Building new mill at Gilt Edge mine, east of Tipton Ford; two shafts; ore from 40 to 80 ft.

FARE & GRAHAM (Klondike)—Completed mill on old Yellow Jacket mine. Using centrifugal pump for dewatering.

CENTURY (Prosperity)—New mill completed to replace Arkansas plant. Now handling 2,500 tons weekly and will increase output. Ore running from 2.4 to 2.75%.

MILTON (Webb City)—New mill being built by G. W. Field, of Boston. He is officer of National Zinc and Lead Co., but this mine is personal investment.

MISSOURI ZINC SMELTING CO., of Webb City, is the title of a new company formed by Webb City men to acquire and operate the Rich Hill, Mo., zinc smeltery. Plant is turned in as full payment of capital stock of $100,000.

Northern Arkansas

SHIPMENTS for week totaled 1,300,000 lb., 22 carloads.

SURE POP NO. 2 (Rush)—New mill well under way.

MONTANA

Cascade County

QUEEN OF THE HILLS (Neihart)—Anaconda company now working about 40 men on this group of old silver mines; also on Galt and Broadwater mines in this camp; all were important silver producers in early days.

Deer Lodge County

BLUE EYED NELLIE (Anaconda)—This old lead-silver mine, a few miles west of city, has been reopened for zinc; tramway built from shaft to bottom of hill may be used jointly by other old mines of camp, including the Gladstone, Horn Silver, Keystone, Crystal Fraction, Blue Lead, Whale and Silver Basin.

Silver Bow County

EAST BUTTE (Butte)—The 1,800-ft. level of No. 2 shaft now being opened. About 20% of ore is obtained through Dutton shaft. Daily output of company's mines about 4,000 tons.

TUOLUMNE (Butte)—Acquired control of Colusa-Leonard and Butte Main Range properties, adjoining Leonard mine on east and Tropic mine on north, by agreement to do about $500,000 development.

ANACONDA (Butte)—This company is shipping about 150 tons daily from Tropic mine on extreme eastern edge of Butte's producing section; ore being mined from 500- to 900-ft. levels; new 600-gal. pump ordered for 1,600 level. In Nettie mine, in western section, development of silver vein encountered on 500 level continues favorable and shipments may be begun in few weeks.

NORTH BUTTE (Butte)—Pres. Thomas F. Cole recently announced that the north crosscut on 2,200-ft. level from Granite Mountain shaft had cut 4½ to 5 ft. of 10% ore; breast still in ore. On 800-ft. level, crosscutting in progress to reach Sioux Chief vein, which had been disclosed for 107 ft. with an average width of 9 ft. on the 700 ft. level, where it averaged 5.1% Cu and 3 oz. Ag. Diamond-drill exploration will be undertaken below 1,500-ft. level.

NEBRASKA

AMERICAN SMELTING AND REFINING (Omaha)—All employees working 10 hr. will hereafter work but eight, with same daily wages as previously.

NEVADA

Clark County

INGOMAR (Goodsprings)—Recently purchased by S. S. Arentz and associates of Salt Lake. Tramway constructed and shipments will soon commence.

ANCHOR (Goodsprings)—Dry concentrator operating successfully, shipping about 400 tons per month; dividend of 1c. per month being maintained. R. W. Moore in charge.

SULTAN (Goodsprings)—New compressor, air hoist and drills being installed; about 300 tons per month of zinc-carbonate ore being shipped. Henry Robbins, owner.

BULLION (Goodsprings)—Sold for $50,000 to Salt Lake men; property equipped with dry concentrating plant; producing about 250 tons of lead concentrate monthly. Thomas Vardon will be in charge.

Churchill County

NEVADA HILLS (Fairview)—In quarter, ended Mar. 31, milled 12,366 tons yielding $72,519; operating profit, $16,424. Company has acquired tungsten property in Arizona. Development of Oro Fino property suspended.

Humboldt County

ROCHESTER MINES (Rochester)—Strike in south drift on West vein now reported to assay 60 oz. silver across 7 ft. The orebody at the north end of the property on the 150-ft. level is running as high as $25 across 5 ft.

Lincoln County

PRINCE CONSOLIDATED (Pioche) — Some of equipment for company's new 200-ton concentrator now at Bullionville; will treat Bullionville and Dry Valley tailings.

Nye County

TONOPAH ORE PRODUCTION for week ended May 20 was 9,520 tons valued at $196,638, compared with 9,001 tons for week previous. Producers were: Tonopah Belmont, 2,929 tons; Tonopah Mining, 2,800; Tonopah Extension, 1,850; Jim Butler, 850; West End, 471; Halifax, 209; Rescue-Eula 155; MacNamara, 40; miscellaneous 216 tons.

Storey County

MEXICAN (Virginia)—On 2,500 level extended north and south prospecting drifts in porphyry and quartz of fair assay. On 2,700 level, east crosscut in vein matter, low assay. Mexican mill received 484 tons custom ore averaging $35.40.

CROWN POINT-BELCHER (Gold Hill)—Extracted 517 cars of ore from 1,600 level and 77 cars saved from Jacket, 300 level. Water held 65 ft. below 1,600 level. Jacket mill received 406 tons mine ore and 452 tons dump rock. Four miners burned to death by Yellow Jacket shaft fire, started on May 23 at 1,400 level by blowing of fuse.

UTAH

Juab County

TINTIC SHIPMENTS for four weeks ending May 20 amounted to 864 cars, as follows: 192, 208, 222 and 242 cars.

CHIEF CONSOLIDATED (Eureka)—A 200-ft. railroad spur completed to this property; made necessary by increased tonnage being shipped, and will allow 12 or 13 cars to be held here.

TINTIC MILLING (Silver City)—Understood to have more than made expenses during April, and better results anticipated for May. Satisfactory recoveries being made of all metals except gold. High price of chemicals, especially for acid and chloride of lime, are making it difficult to get good recovery without greatly increasing operating costs. T. P. Holt, superintendent of the plant, is working on an electrolytic process, which may make it possible to get better recovery. Capacity of plant at present is 100 tons a day, and might have been increased but for difficulty with the Knight-Christensen roasters. Ore being treated is coming from the Iron Blossom and Dragon properties.

Salt Lake County

ALBION (Alta)—Lessees in old workings have several cars silver-lead-copper ore ready.

LOGGER (Salt Lake)—Tunnel in Big Cottonwood Cañon is in 365 ft. following mineralized fissure.

SILVER SHIELD (Bingham)—Ore continues in openings in both of new discoveries; one car shipped and another nearly ready.

WASATCH MINES (Alta)—Shipments will soon be made by company and by lessees. Surveys completed for new drainage and operating tunnel.

SOUTH HECLA (Alta)—Ore stored in bins and broken in mine estimated at 2,250 tons. Forty men working, and force will be increased to 75. Nine 4-horse teams are hauling ore. Orebody followed 300 ft. horizontally and is up to 25 ft. thick; on the pitch it has been followed 490 ft. to surface, outcropping at old Wedge shaft.

Summit County

A NEW MILL being built by J. M. Fallon and John Hendrickson on Silver Creek below Park City to treat tailings. Concentration on tables will be followed by flotation.

DALY WEST (Park City)—Mill started May 20, after a shutdown of several months, due to lack of water.

NAILDRIVER (Park City)—This property, which recently closed down, will resume work under 18-month lease to John D. Fisher.

CANADA

Ontario

HUDSON BAY (Cobalt)—Mine to be reopened.

VIPOND (Porcupine)—Loss of $355 in operating last three months.

KERR LAKE (Cobalt)—Relinquished option on Smith-Labine property at Sesekinika.

KENZIE (Boston Creek)—A one-tenth interest in this property sold for $10,000.

TOUGH OAKES (Kirkland Lake)—Rich ore encountered in oreshoot on No. 6 vein at 250-ft. level.

CROESUS (Munroe)—Producing about $1,000 a day in high-grade gold ore from development.

WEST DOME CONSOLIDATED (Porcupine)—Cut 5 ft. of $45 ore in diamond-drill hole at depth of 513 ft.

PORCUPINE CROWN (Porcupine)—Installing extra thickeners in mill on account ore from lower levels running higher in sulphides.

McEWEN BROWN CLAIM (Beatty Township)—Narrow rich vein found by McEwen Brown, 2 mi. west of the Croesus; optioned by C. A. Foster who is developing.

DOME EXTENSION (Porcupine)—Dome Mines, Ltd., has begun testing this property by diamond drilling; contract let to James W. Reed. First hole will be put down at least 1,500 ft.

DOMINION RAND (Porcupine)—On this company's north property in Deloro Township, new vein varying from 1 to 4 ft. in width and 500 ft. long has been disclosed. Dike, carrying gold, also encountered on the east.

HOLLINGER (Porcupine) — Four-weekly statement for Apr. 21 shows gross profits $158,646, from 29,590 tons of ore, average value $9.09; working cost, $3.54 per ton milled. Mill also treated 13,083 tons of Acme ore. Increased rates for surface labor 25c. a day and also increased rate of loyal-service bonus to underground men.

Quebec

JOHNSON (Thetford Mines)—E. Morrissette and J. Bruneau were instantly killed and Joseph Turcotte had his leg broken by rock slide in this asbestos mine on May 19.

Yukon Territory

CANADIAN KLONDYKE (Dawson)—No. 1 dredge started Apr. 17; cleanup Apr. 29 was 9[illegible] oz. No. 2 dredge started May 10; Nos. 3 and 4 expected to [illegible]low shortly; delayed by loss of repair parts in shipwreck.

MEXICO

Sonora

ORE EXPORTS FROM SONORA through Agua Prieta for April were: Nacozari, 9,396 tons; El Tigre, 234; Churunibabi, 47; Anteguera, 16; Santa Margarita, 18; Panama, 18; Rosario, 22; Bella Union, 11; Saint Sava, 32; La Cruz, 7; Esperanza, 32; Promontorio, 171; Belen, 126; San Francisco, 28; La Fortuna, 27; total, 10,185; El Tigre also shipped 30 bars silver bullion weighing 3,916 lb.

BELEN (Cumpas)—Shipping about one car per week; developing and concentrating.

MONTE CRISTO (Moctezuma)—Management assumed by Laskin Bros. of El Paso; shipping a car a month of high-grade ore.

ARCHIPELAGO (Cumpas) — John Boyd just placed in charge; shipping 3 to 10 tons daily; body of 14% copper ore in new shaft.

WASHINGTON (Cumpas)—F. O. Bostwick, one of owners, when arranging to put in mill discovered that ore contained scheelite; has shipped about 9 tons of 60% concentrates.

TRANSVAAL (Cumpas)—Leo G. Cloud has leased mine and unwatered Ultima Chanza shaft; has developed vein of 20% copper ore carrying silver and gold. Four cars shipped and more on the road.

BOLIVIA

AN EXTRAORDINARY GOLD NUGGET weighing 14 lb. is reported to have been found by an Indian working in the Chuquiaguillo placer near La Paz. This placer was sold two years ago at receivership sale to Benedicto Goytia, former president of the Bolivian Senate, and has been worked lately by Indian tributers.

CHOSEN

ORIENTAL CONSOLIDATED (Unsan)—In March, crushed 26,918 tons, yielding $157,061; operating costs, $70,227; net profit, $87,384.

INDIA

BURMA CORPORATION (Bawdwin)—Tiger tunnel, to open Chinamen orebody at depth of 500 ft., now in over 5,000 ft.; estimated length about 6,000 ft. Monthly progress over 300 ft., with machine drills.

The Market Report

Metal Markets

NEW YORK—May 31

All of the metal markets were again reactionary last week, the recession being most pronounced in zinc and copper. Lead and tin were both soft. No large volume of business was done in any of the metals.

Copper, Tin, Lead and Zinc

Copper—The total volume of business was extraordinarily light, and so far as reported to us was chiefly for June-July and for August deliveries. The premium on prompt copper has entirely disappeared. Copper for shipment during the last quarter of the year has been offered liberally at 26c. regular terms.

The reaction in copper is regarded among producers with entire unconcern, most of them having sold their output far ahead. The recession is what naturally happens in a dull market, there being always some interests that have copper and want to sell it.

Copper Sheets are unchanged at 37.5c. for hot rolled and 38.5c. for cold rolled. Copper wire is 33¼@33¾c. per lb. for large lots at mill.

Copper Exports are expected to reach a large total for May, as there have been a number of heavy shipments, especially to France.

Tin—This market also was dull. On May 31 there was a sharp decline, reflecting the weakness in London.

Arrivals of tin and tin concentrates at Liverpool in April, reduced to equivalents in metallic tin, were, in gross tons: Bolivian, 1,730; Nigerian, 565; total, 2,295 gross tons.

Corrected shipments of tin from the Straits Settlements in April were 4,645 gross tons

Lead—Domestic business was light. Some export business was done right along at full prices, especially from Pacific Coast ports. In the St. Louis market there was talk about some very low prices, but offers apparently did not emanate from producers. The latter were fairly firm in their attitude, there being no accumulation of stocks in their hands above the normal working stocks. On transactions actually reported prices varied considerably according to kind of lead. The Japanese contract, respecting which there was much talk last week, was awarded to Japanese houses.

Spelter—The decline in this metal continued on relatively light business. Some moderately large foreign orders were taken, but these were not sufficient to halt the decline. Consumers were again offering to resell prompt spelter in rather large quantities. Large producing interests continued to hold aloof, but there were increasing signs that smaller producers are willing to meet the market. June spelter is in fairly liberal supply, and for delivery later than June there appears to be plenty, producers not being very well sold beyond June. For this reason the difference between the prices for near-by and later deliveries has contracted materially. In the early part of the week producers were offering July-December spelter at 12c., and at the close July-December was freely offered at 11 cents.

Zinc Sheets are again easier although a good demand is reported. The price had eased off another cent and is today $22.50 per 100 lb. f.o.b. Peru, Ill., with 8% discount.

Other Metals

NEW YORK—May 31

Antimony—The market remains dead, further recessions in price failing to bring out business Spot has been offered at 25c. per lb. carload lots. Shipment from China within one month is quoted nominally at 21@22c. per lb., c. i. f., New York, duty unpaid.

Aluminum—The market continues to show a fair demand. As for several weeks past this has been satisfied by contract deliveries, which are now rather free. Outside material is still scarce. Current quotations are 58@60c. per lb. No. 1 ingots New York.

Nickel—The market continues steady with about the same amount of domestic business as usual and with rather a brisk demand for export. Quotations are 45@50c. per lb. for ordinary forms, according to size and terms of order. Electrolytic nickel brings 5c. per lb. premium.

Quicksilver—The market is weak and rather uncertain. Purchasers seem to be holding back as much as possible, and will probably wait until the market turns again before ordering. The New York price is $78 per flask of 75 lb. for large lots; $80@81 for smaller orders, but quotations are rather irregular. San Francisco reports by telegraph $80 per flask with a quiet market. The London price continues fixed at £16 10s. per flask.

DAILY PRICES OF METALS IN NEW YORK

May	Sterling Exchange	Silver, Cts. per Oz.	Copper	Tin	Lead		Zinc
			Electrolytic, Cts. per Lb.	Spot, Ctc. per Lb.	New York, Cts. per Lb.	St. Louis, Cts. per Lb.	St. Louis, Cts. per Lb.
25	4.7575	71⅛	27⅛ @28⅛	48	7.40 @7.50	7.25 @7.42½	12.25 @13.25
26	4.7581	71⅛	27⅛ @28	47⅛	7.37½ @7.50	7.12½ @7.42½	12.00 @13.00
27	4.7575	71⅛	27⅛ @28	47	7.37½ @7.50	7.12½ @7.42½	12.00 @12.75
29	4.7575	70⅛	27⅛ @27⅜	47	7.25 @7.50	7.10 @7.40	11.87½ @12.62½
30	.....	...	.....	..	.....	.....	.....
31	4.7575	68⅛	27⅛ @27⅜	45⅛	7.25 @7.50	7.10 @7.40	11.50 @12.00

The quotations herein are our appraisal of the average markets for copper, lead, spelter and tin based on wholesale contracts for the ordinary deliveries of the trade as made by producers and agencies; and represent, to the best of our judgment, the prevailing values of the metals, reduced to basis of New York, cash, except where St. Louis is given as the basing point. St. Louis and New York are normally quoted 0.17c. apart.

The quotations for electrolytic copper are for cakes, ingots and wirebars. Electrolytic copper is commonly sold at prices including delivery to the consumers and is subject to discounts,etc. The price quoted for copper on "regular terms" (r.t.) is the gross price including freight to the buyer's works and is subject to a discount for cash. The difference between the price delivered and the New York cash equivalent is at present about 0.25c. on domestic business. The price of electrolytic cathodes is 0.05 to 0.10c. below that of electrolytic. Quotations for lead represent wholesale transactions in the open market for good ordinary brands. Quotations for spelter are for ordinary Prime Western brands. Only the St. Louis price is herein quoted, St. Louis being the basing market. We quote the New York price at 17c. per 100 lb. above the St. Louis price.

Silver quotations are as reported by Handy & Harman and are in cents per troy ounce of fine silver.

Some current freight rates on metals per 100 lb. are: St. Louis-New York 17c.; St. Louis-Chicago, 6.3c.; St. Louis-Pittsburgh, 13.1c.

LONDON

May	Silver	Copper				Tin		Lead		Zinc	
		Standard		Electrolytic							
		Spot	3 Mos.	£ per Ton	Cts. per Lb.	Spot	3 Mos.	£ per Ton	Cts. per Lb.	£ per Ton	Cts. per Lb.
25	34 1/16	129	128	152	32.36	192⅛	192¼	31⅛	6.68	95	20.22
26	34 1/16	121	120	148	31.51	193	193	31¼	6.71	90	19.14
27	34 1/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	33⅞	126	125	148	31.51	193	192⅛	31⅛	6.76	80	17.04
30	32⅞	121	119	148	31.51	190	189⅜	31⅛	6.76	80	17.04
31	32⅞	121	119	148	31.51	187⅛	187	31⅛	6.81	80	17.04

The above table gives the closing quotations on London Metal Exchange. All prices are in pounds sterling per ton of 2240 lb., except silver which is in pence per troy ounce of sterling silver, 0.925 fine. Copper quotations are for standard copper, spot and three months, and for electrolytic, price for the latter being subject to 3 per cent. discount. For convenience in comparison of London prices in pounds sterling per 2240 lb., with American prices in cents per pound the following approximate ratios are given, reckoning exchange at 4.80. £ 15 = 3.21c.; £20 = 4.29c.; £30 = 6.43c.; £40 = 8.57c.; £60 = 12.85c. Variations, £1 = 0.21⅜c.

Gold, Silver and Platinum

NEW YORK—May 31

Gold shipments have continued to come from Canada during the past week and the total receipts on the present movement are now nearly $21,000,000. It is thought that the reserve supply at Ottawa has been nearly exhausted. Some people have started the theory that South African gold is coming here by this roundabout way.

The Norwegian Government proposes to release the State Bank from the obligation to accept all gold offered to it for coinage. The reason is the great accumulation of gold in Norway The Bank will be allowed to accept bullion for deposit. The Swedish government is considering the same action.

Platinum—The market has been very dull here with very little business forward. The high price is discouraging to manufacturers and jewelers are not buying this season. The apparent price is $80 per oz. for refined platinum, with $84@86 for hard metal, according to quality.

Our Russion correspondent writes that during the last fortnight, since the platinum industry and market were declared free from official control, there has been a considerable revival in activity. In Petrograd, some quantities have been sold at 68,000 rubles per pood and negotiations are pending for a further sale of about 10 poods. There is a good demand for internal use in connection with war purposes. It is the general opinion of the large dealers that further advance in prices is probable. The quotations for crude metal, 83% platinum, are 68,000@69,000 rubles per pood at Petrograd and 17.25@17.50 rubles per zolotnik at Ekaterinburg. These prices are equivalent to $67.13 and $65.33 per oz. respectively, on the average.

Silver has declined owing to speculative operations, China selling, and in all probability pooling arrangements. The underlying conditions have not materially changed, and as the amount of silver in London—about 7,000,000 oz. at last account—is not large, it is quite possible to manipulate the market toward higher prices.

Samuel Montague & Co. write from London as follows: "The influence of the great war upon currency is very far-reaching. For example, it was stated in the National Review of Shanghai that merchants in Shangtung and elsewhere, especially of a certain nationality, were buying up copper and other coins and melting them down for sale and export abroad This practice is, of course, illegal, and very few Chinese are engaged upon it because they realize the risk of heavy punishment which they run. The more, however, the practice is extended, the more need will arise for small silver coins, and it is not impossible that the loss of a certain amount of copper currency is one of the reasons why China is not in a position to export silver on the scale that recently took place, notwithstanding the great rise that has since occurred in the price."

Zinc and Lead Ore Markets

PLATTEVILLE, WIS.—May 13

The base price paid this week for zinc ore was $80@83 per ton for top grades down to $75 base for medium grades assaying down to 52%. The base price paid for 80% lead was $90 per ton.

SHIPMENTS WEEK ENDED MAY 27

	Zinc Ore, Lb.	Lead Ore, Lb.	Sulphur Ore, Lb.
Week	5,246,000	487,590	517,500
Year	93,710,000	3,488,520	25,590,800

Shipped during week to separating plants, 5,954,000 lb. zinc ore.

JOPLIN, MO.—May 27

Blende, high price, $98.10; per ton 60% zinc, premium ore, $95; medium grades, $90@75, and lower grades down to $70; calamine, per ton 40% zinc, $50@42; average selling price, all grades of zinc, $82.21 per ton.

Lead, high selling price, $95.15; purchasing price for future delivery per ton 80% metal content, $92.50; average selling price, all grades of lead ore, $93.36 per ton.

SHIPMENTS WEEK ENDED MAY 20

	Blende	Calamine	Lead	Values
Totals this week..	12,157,090	782,040	2,430,020	$645,300
Totals this year...	296,391,490	24,932,080	50,318,070	$19,324,760

Blende value, the week, $511,560; 5 months, $16,097,030.

Calamine value, the week, $20,310; 5 months, $927,530.

Lead value, the week, $113,430; 5 months, $2,299,600.

At a meeting of producers held Thursday the cessation of night work was discussed, many favoring immediate action. Though strongly favored no definite action was taken. It is believed tonight some producers will act independently and by reducing the demand for labor forestall the possibility of labor trouble next month. The wage-scale settlement, based on the average base price of blende during the month, presages a severe cut for June, with the May average $90.62½ per ton, against $108.50 for April, or a decline of $17.87½. The heavier demand noted a week ago increased the shipment 1,900 tons over the previous week. Buying on the lower level of prices is of better tone tonight, but a further decline is anticipated.

OTHER ORES

Antimony Ore—There has been some inquiry for ore, but no business has been done. Prices remain purely nominal at $2.50 per unit.

Tungsten Ore—The market has not seen much change during the past week though all indications are that it has reached about bottom for the time being and will gradually get into a steadier growth again. Several lots in the hands of speculators are pressed upon the market and have rather a disturbing affect. Once, however, these lots are disposed of, prices should be steadier. Prices at $40 per unit are entirely nominal. Very little material is coming in.

The Formen Trading Co. of New York has begun the manufacture of tungstic acid at a new plant located at Reading, Penn. The acid is being manufactured from scheelite ores. The daily output will be about one ton of acid. This material has been tested by several large steel mills and has proved to be satisfactory to them.

Iron Trade Review

NEW YORK—May 31

The export trade continues to supply the chief part of the new business coming forward, but that is sufficient to keep the mills busy.

PITTSBURGH—May 30

The situation in the steel trade continues very much in the same position as a week ago. Reference was made last week to the very large tonnage of shell steel booked by the Steel Corporation and the total of war steel placed with independents. There is still some inquiry for war steel and it is evident that a large tonnage may be secured. The great difficulty in the way is that many mills are not prepared to take contracts for the deliveries required, which may cause some trouble. In the meantime, very few orders for domestic material are coming in, partly because of the high prices, but partly also because of the probable delay in deliveries of material. Barbed wire for export is still in strong demand and is being taken for delivery all over the first half of next year. The principal domestic business offering now is in the contracts for bars for the agricultural machinery people in the first half of next year.

So far as work goes, most of the mills are abundantly provided with orders to keep them busy through the balance of the present year. There is less apprehension now than there was about labor conditions, and not much difficulty is anticipated at the present scale of wages. There is still some trouble outside the mills and the molders' strike persists rather stubbornly.

Pig Iron—The market is hardly as stiff as it was for some grades, although there has been a good demand for bessemer and basic pig. The market as a whole is rather quiet, but shows a fairly good undertone, under all the conditions. Bessemer and basic hold their prices fairly well and sellers continue pretty stiff on foundry, notwithstanding the presence of some resale lots on account of the molders' strike: We quote: Bessemer, $21@21.50; basic, $18.25@18.50; foundry, $18.50@18.75; malleable, $18.25@18.75; forge, $18@18.25. These prices are all f.o.b. Valley furnaces, 95c. higher delivered Pittsburgh.

Steel—The recent large sales of steel do not seem to have affected the ordinary market to any great extent, except that offers are not quite so free. Bessemer and openhearth billets and steel bars can be had at $42@45 a ton, but it is not easy to get extended contracts at these prices. Forging billets remain at $65@70 per ton with rods from $55@60 at mill. On the whole, the market is a little easier, except in the case of forging billets for which there is a pretty strong demand. There do not seem to be any accumulations of material left at any of the mills.

FERROALLOYS

Ferromanganese—Imports at Baltimore for the week included 1,014 tons ferromanganese from Liverpool.

At Pittsburgh inquiry is not so large and is less urgent, most consumers being evidently supplied or having contracts in sight to cover their requirements. Some sales of domestic

ore reported at $325 @350 per ton for early delivery. The contract price for imported remains at $175 for 1917, production for this year being sold out.

Ferrosilicon—High grade, 50%, is still nominally $83@85 per ton at furnace. The supply is a little better, but premiums are charged for early delivery. Bessemer ferrosilicon is quoted at $33 for 10% up to $43 for 16%, at furnace.

Spiegeleisen is in demand and is held at $75 per ton for 20% at furnace.

FOREIGN IRON

The number of blast furnaces active in Great Britain during the quarter ended Mar. 31 was 288. At the close of the quarter there were 285 stacks in blast.

Steel Production in Germany in March was 1,361,502 metric tons, an increase of 124,657 tons over February. For the three months ended Mar 31 the output was in metric tons:

	Basic	Acid	Total
Converter	1,825,610	37,841	1,863,451
Openhearth	1,565,562	89,313	1,654,875
Direct castings	149,437	75,304	224,741
Crucible	.....	26,640	26,640
Electric	.....	44,623	44,623
Total	3,540,609	273,721	3,814,330

The Steel Syndicate has advanced prices on several classes of finished products.

EXPORTS AND IMPORTS

Copper Exports from Japan for the year are given as follows, in gross tons:

	1915	1916	Changes
China	16,410	1,520	D. 14,890
India	2,440	1,220	D. 1,220
Asiatic Russia	5,000	29,000	I. 24,000
Great Britain	6,790	12,200	I. 5,140
France	3,470	3,940	I. 470
Germany	2,100	.....	D. 2,100
United States	4,680	7,800	I. 3,120
Other countries	2,110	320	D. 1,790
Total	43,000	56,000	I. 13,000

The heavy increase in shipments to Russia should be noted. No shipments are reported made during 1915 to Germany.

Exports of Metals and Minerals from Spain, month of January, as reported by "Revista Minera" in metric tons:

	Metals		Ores, etc.	
	1915	1916	1915	1916
Iron	14,656	7,480	271,134	345,623
Copper	263	1,673	1,004	5,583
Copper precipitate	161	1,231	.....	.....
Lead	12,514	15,026	10	446
Zinc	28	60	.....	3,129
Quicksilver	7	208	.....	.....
Manganese	.....	.....	3	1,770
Pyrites	.....	.....	72,834	262,977
Salt	.....	.....	24,957	46,015

Imports of coal for the month were 153,479 tons, an increase of 34,730 tons over January, 1915; imports of coke, 14,743 tons, an increase of 5,279 tons.

EXPORTS AND IMPORTS

Some important exports and imports in France in 1915, as compared with 1914, are given in a report from U. S. Consul-General Thackara as follows, in metric tons:

	Imports		Exports	
Raw Materials	1914	1915	1914	1915
Coal	15,430,258	19,067,743	.....	.....
Iron ore	1,044,160	397,348	4,828,592	94,864
Metals, etc.:				
Copper	78,522	111,400	.....	.....
Tin	7,216	9,003	.....	.....
Iron and steel	109,550	927,358	419,142	152,117
Machinery	149,560	100,576	57,738	15,475
Tools and metal goods	46,810	164,730	100,977	28,220

The sharp changes shown in the table are due entirely to the conditions arising from the war.

SAULT STE. MARIE CANAL TRAFFIC

The total freight passing through the Sault Ste. Marie Canals in April was: East bound, 1,566,915; west bound, 648,447; total, 2,215,362 net tons; an increase of 880,627 tons over April, 1915. Of the total 1,825,210 passed through the United States and 390,152 tons through the Canadian Canal. The number of vessels was 698, showing an average cargo of 3,174 tons. The mineral freights included in the totals were, in net tons, except salt, which is given in barrels:

	1915	1916	Changes
Anthracite	130,111	100,800	D. 29,311
Bituminous coal	149,455	505,598	I. 356,143
Iron ore	411,845	875,307	I. 463,462
Pig and manufactured iron	8,580	6,049	D. 2,531
Copper	5,749	.....	D. 5,749
Salt, bbl	50,937	45,999	D. 4,938

The United States Canal opened this year on Apr. 20, and the Canadian Canal on Apr. 18, giving only about 10 days for traffic.

IRON ORE

Imports of iron ore in Great Britain in the four months ended Apr. 30 were 1,881,449 gross tons in 1915, and 2,056,279 tons in 1916; increase, 174,830 tons.

COKE

Coke production for the week in the Connellsville region is reported by the "Courier" at 436,441 net tons; shipments, 434,190 tons. Shipments of Greensburg and Upper Connellsville districts, 39,363 tons.

Connellsville—The market is very quiet with practically nothing doing. There are many complaints of labor shortage in the coke region and a general anticipation that this condition will become worse later in the year. The advance in mining rates in this region has increased the cost of making coke and makers are not willing to give way or to cut down prices in concluding contracts. Demands for spot are not very large. For second half some contracts are soon to be closed, but the parties are not very close together and nothing is being done. Quotations are about as follows: Spot furnace, $2.25@2.40; contract, $2.50@3 nominal; spot foundry, $3.50@3.75; contract foundry, $3.50 per net ton at ovens.

Coal and Coke Tonnage Pennsylvania R.R. lines east of Fittsburgh and Erie four months ended Apr. 30, in net tons:

	1915	1916	Changes
Anthracite	3,607,419	3,995,058	I. 387,639
Bituminous	13,203,746	16,598,440	I. 3,394,694
Coke	3,136,262	4,932,751	I. 1,796,489
Totals	19,947,427	25,526,249	I. 5,578,822

The total increase this year was 28%; the largest proportional gain being in coke. The total for the month of April was 5,900,222 tons, an increase of 583,043 tons over last year.

Fuel Exports of Great Britain four months ended Apr. 30, in gross tons:

	1915	1916	Changes
Coal	14,989,490	12,251,558	D. 2,737,932
Coke	305,697	479,378	I. 173,681
Briquettes	388,907	444,409	I. 55,502
Bunker coal	5,154,395	4,236,038	D. 918,357
Total	20,838,489	17,411,383	D. 3,427,106

The bunker coal includes coal sent abroad for the use of steamships in foreign trade. The exports were about two-thirds of those in a normal year.

Chemicals

NEW YORK—May 31

The general market is rather unsteady and irregular as the dull season approaches. Heavy chemicals are inclined to be uncertain, with a lower tendency. Acids are strong and active.

Arsenic—Supplies are good and trading has been moderate only. Prices are a little easier, $6.25 per 100 lb. being paid for spot and $6@6.25 per 100 lb. for June.

Copper Sulphate—Export orders have fallen off and sales have been rather slow. The market is again weaker and sales have been made at 15@16c. for carload lots.

Nitrate of Soda—Trade statistics continue rather unfavorable, with a large production going on. The quotations are inclined to be firm. Spot sales are made at $3.10 per 100 lb., while $3.15@3.20 per 100 lb. is asked for futures.

A cable received by the Department of Commerce from the American Consulate at London says: "The Russian government committee in London announces that all shipments to Vladivostok of nitrate of soda 95-96%, will be requisitioned by the government at not more than £18 ($93, at the normal exchange rate) per ton, also nitrate of soda for agriculture at not more than £12 ($58) per ton ex-ship Vladivostok, unless shipped with the previous authorization of the Russian government committee in London."

Pyrites—Imports at Baltimore for the past week included 5,814 tons iron pyrites from Huelva, Spain.

Sulphur—Freight rates remain high and there is not very much material for early delivery. Spot is held at $35 per long ton, with $30 asked for futures.

Sulphuric Acid—Trading for the week has been mainly for small lots, but there are inquiries for some large quantities. The quotations are $22@25 per ton for 60-deg. acid at works. For 66-deg. acid $50 per ton is asked for early delivery and $45 for second half.

Assessments

Company	Delinq.	Sale	Amt.
Advance, Mont.	June 15	July 15	$0.005
Algomah, Mich.	May 18	.....	1.00
Alpha, Nev.	June 7	June 28	0.03
Andes, Nev.	May 9	May 31	0.02
Best & Belcher, Nev.	June 9	June 28	0.05
Challenge, Nev.	June 12	July 7	0.05
Coeur d'Alene Antimony, Ida.	June 3	.....	0.01
Con. Virginia, Nev.	May 19	June 9	0.05
East Hercules Ext., Ida.	May 1	July 3	0.0015
Emerald, Utah.	May 15	June 10	0.0033
Emerald, Utah.	June 15	July 8	0.0033
Enterprise, Ida.	May 20	June 20	0.001
Federal Ely, Nev.	May 1	June 4	0.005
Four Timbers, Ida.	May 5	June 5	0.001
Goldstrike Bon., Utah.	June 15	July 15	0.01
Howell, Utah.	Apr. 15	June 3	0.01
Idaho & Los Angeles, Ida.	June 2	July 1	0.005
Imperial, Ida.	June 12	July 12	0.005
Kewanas, Nev.	May 1	June 5	0.01
McKinley, Utah.	May 22	June 15	0.0025
National, Ida.	June 2	July 3	0.02
Nine Mile, Idaho.	May 12	June 1	0.0015
North Franklin, Ida.	June 19	July 8	0.005
Old Veteran, Ida.	May 6	June 3	0.02
Overman, Nev.	May 3	May 23	0.05
Phedora, Ida.	May 9	July 1	0.005
Rio Grande, Nev.	May 22	July 22	0.002
Rob Roy, Ida.	June 10	July 10	0.002
Roosevelt, Utah.	June 1	July 1	0.02
Silver Cable, Ida.	May 22	June 10	0.005
Silver Star, Ida.	June 14	July 1	0.002
Smuggler, Utah.	May 15	June 1	0.0025
Snowstorm Ext., Idaho.	May 9	June 13	0.003
Sonora, Ida.	June 5	June 30	0.004
Sunset, Ida.	June 3	June 24	0.002
Tarbox, Ida.	May 6	June 20	0.05
Uvada, Nev.	June 24	July 27	0.02
Western Pacific, Utah.	May 16	June 6	0.00½

Sold at auction during the last week: 225 Argonaut Mining Co. at $6¾ per share; 1,968 White Knob Copper and Development Co., Ltd., pfd., and $7.50 scrip, at $1.85 per share.

Stock Quotations

SAN FRANCISCO May 25	
Name of Comp.	Bid.
Alta.	.04
Andes.	.08
Best & Belcher.	.02
Bullion.	.01
Caledonia.	.35
Challenge Con.	‡.05
Confidence.	‡.15
Cons. Imperial.	.01
Con. Virginia.	.18
Gould & Curry.	.02
Hale & Norcross.	.03
Jacket-Cr. Pt.	.07
Mexican.	.20
Occidental.	.70
Ophir.	.25
Overman.	.08
Savage.	.05
Seg Belcher.	.02
Sierra Nevada.	.37
Union Con.	.78
Utah Con.	.01
Belmont.	4.62½
Jim Butler.	.95
MacNamara.	.09
Midway.	.23
Mont.-Tonopah.	.33
North Star.	.18
Rescue Eula.	.47
West End Con.	1.12½
Atlanta.	.12
Blue Bell.	.02
Booth.	.16
C.O.D. Con.	.03
Comb. Frac.	.09
D'field Daisy.	.03
Jumbo Extension.	.92
Pitts.-Silver Peak.	.08
Round Mountain.	.74
Sandstorm Kendall.	.05
Silver Pick.	.09
Central Eureka.	.07
Argo.	.21
Big Jim.	1.25
Lazy Boy.	.20
Oatman Cres.	.42
Oatman No. Star.	.20
Tom Reed.	1.60
United Eastern.	4.37½
United Western.	.20

LONDON	May 17
Alaska Tre'dwell	£6 10s 0d
Burma Corp.	2 11 3
Cam & Motor.	0 15 7½
Camp Bird.	0 9 6
El Oro.	0 10 3
Esperanza.	0 11 6
Mexico Mines.	4 2 6
Nechi, pfd.	0 14 0
Oroville.	0 16 0
Santa Gert'dis.	0 13 6
Tomboy.	1 3 9
Tough Oakes.	‡0 11 3

SALT LAKE	May 29
Name of Comp.	Bid.
Beck Tunnel.	‡.22½
Black Jack.	.12
Colorado Mining.	.20½
Crown Point.	.05½
Daly-Judge.	8.10
Emma Cop.	.70
Gold Chain.	.28
Grand Central.	.70
Iron Blossom.	1.90
Lower Mammoth.	.04½
May Day.	.14
Opohongo.	.02
Prince Con.	1.35
Seven Troughs.	.15
Silver King Coal'n.	2.87
Silver King Con.	3.25
Sioux Con.	.15
Uncle Sam.	.07
Yankee.	.30

COLO. SPRINGS	May 27
Acacia.	.03¾
Cripple Cr'k Con.	‡.00¼
Doctor Jack Pot.	.10½
Elkton Con.	.21
El Paso.	.77
Findlay.	.04
Gold Sovereign.	.03½
Golden Cycle.	2.05
Granite.	.69½
Isabella.	.18½
Jack Pot.	.06
Jerry Johnson.	.04
Mary McKinney.	.38
Portland.	1.76
Vindicator.	2.43

TORONTO	May 29
Bailey.	.09
Chambers Ferland.	.25
Coniagas.	5.00
La Rose.	.62½
Peterson Lake.	.28
Right of Way.	.03½
Seneca Superior.	.50
T. & Hudson Bay.	‡33.00
Temiskaming.	.65
Trethewey.	.25
Wettlaufer-Lor.	.06
Dome Exten.	.35
Dome Lake.	.28
Foley O'Brien.	.45
Hollinger.	29.25
Imperial.	.03½
Jupiter.	.35
McIntyre.	1.75
Porcu. Crown.	.81½
Preston E. D.	‡.04
Vipond.	.56
West Dome.	.28

N. Y. EXCH.	May 29
Name of Comp.	Clg.
Alaska Gold M.	22½
Alaska Juneau.	9½
Am.Sm.&Ref.,com.	98
Am. Sm. & Ref., pf.	113½
Am. Sm. Sec., pf. A	95½
Am. Sm. Sec., pf. B.	87
Am. Zinc.	84½
Anaconda.	85
Batopilas Min.	2
Bethlehem Steel.	454
Bethlehem Steel, pf.	135
Butte & Superior.	91½
Chile Cop.	20½
Chino.	52½
Colo. Fuel & Iron.	43
Crucible Steel.	84½
Dome Mines.	26½
Federal M. & S.	17
Federal M. & S., pf.	37
Great Nor., ore ctf.	40
Greene Cananea.	47
Homestake.	129
Inspiration Con.	45
International Nickel	45½
Kennecott.	54½
Lackawanna Steel.	70½
Miami Copper.	35½
Nat'l Lead, com.	67
National Lead, pf.	113½
Nev. Consol.	17½
Ontario Min.	8½
Quicksilver.	2½
Quicksilver, pf.	3½
Ray Con.	22½
Republic I&S, com.	47
Republic I&S, pf.	111½
Sloss-Sheffield.	54
Sloss-Sheffield, pf.	92
Tennessee Copper.	44½
Utah Copper.	80½
U. S. Steel, com.	85½
U. S. Steel, pf.	117
Va. Iron C. & C.	52

N. Y. CURB	May 29
Adanac.	.62
Alta Con.	.62
Beaver Con.	.40
Buffalo Mines.	1
Butte & N. Y.	2½
Butte C. & Z.	6½
Can. Cop. Corpn.	2 1/16
Cashboy.	.08
Cerro de Pasco.	36
Con. Ariz. Sm.	1½
Con. Coppermines.	2½
Con. Nev.-Utah.	1/16
Dia. Black B.	.06
First Nat. Cop.	4½
Florence.	.45
Goldfield Con.	.95
Goldfield Merger.	.11½
Granite.	.47
Hecla Min.	4 11/16
Howe Sound.	5½
Jerome Verde.	2½
Kenefick Zinc.	13½
Kerr Lake.	4½
Magma.	16
Majestic.	.78
McKinley-Dar-Sa.	.60
Mines of Am.	2½
Mother Lode.	.30½
Nevada Hills.	.35
New Utah Bingham	‡2½
Nipissing Mines.	7½
Oro.	.05½
Ray Hercules.	4½
Rochester Mines.	.72
St. Joseph Lead.	16½
Standard S. L.	1 1/16
Stewart.	1/32
Success.	.75
Tonopah.	6½
Tonopah Ex.	6 7/16
Tribullion.	⅛
White Knob, pf.	2
Yukon Gold.	2½

BOSTON EXCH	May 29
Name of Comp.	Bid
Adventure.	3½
Ahmeek.	400
Algomah.	1½
Allouez.	68
Ariz. Com., ctfs.	8½
Bonanza.	.30
Butte-Ballaklava.	2½
Calumet & Ariz.	73½
Calumet & Hecla.	555
Centennial.	16
Copper Range.	63½
Daly West.	2½
East Butte.	12½
Franklin.	8½
Granby.	87
Hancock.	14½
Hedley.	‡20
Helvetia.	.35
Indiana.	3
Island Cr'k, com.	49
Island Cr'k, pfd.	91
Isle Royale.	27½
Keweenaw.	5½
Lake.	15
La Salle.	3½
Mason Valley.	3
Mass.	12½
Mayflower.	3
Michigan.	3½
Mohawk.	94½
New Arcadian.	7
New Idria.	14½
North Butte.	23½
North Lake.	1
Ojibway.	2
Old Colony.	2½
Old Dominion.	69
Osceola.	93½
Quincy.	95½
St. Mary's M. L.	‡76
Santa Fe.	2½
Shannon.	8½
Shattuck-Ariz.	31½
So. Lake.	7
So. Utah.	.30
Superior.	16½
Superior & Bost.	4½
Tamarack.	52
Trinity.	6½
Tuolumne.	.50
U. S. Smelting.	73½
U. S. Smelt'g, pf.	51½
Utah Apex.	4½
Utah Con.	14½
Utah Metal.	9
Victoria.	3½
Winona.	6½
Wolverine.	56
Wyandot.	1½

BOSTON CURB	May 29
Bingham Mines.	14½
Boston Ely.	.45
Boston & Mont.	1½
Butte & Lon'n Dev.	.70
Calaveras.	4½
Calumet-Corbin.	.05
Chief Con.	1 11/16
Cortez.	.50
Crown Reserve.	.50
Davis-Daly.	1½
Eagle & Blue Bell.	2½
Houghton Copper.	1½
Iron Cap Cop., pf.	6½
Mexican Metals.	.34
Mojave Tungsten.	6½
Nat. Zinc & Lead.	2 1/16
Nevada-Douglas.	1½
New Baltic.	2½
New Cornelia.	14
Ohio Copper.	.13
Oneco.	1
Raven Copper.	.18
Rex Cons.	.29
Rilla.	.93
United Verde Ext.	26½

‡Last Quotations.

Monthly Average Prices of Metals

SILVER

Month	New York			London		
	1914	1915	1916	1914	1915	1916
January.	56.572	48.855	56.775	26.553	22.731	26.960
February.	57.506	48.477	56.755	26.573	22.753	26.975
March.	58.067	50.241	57.935	26.788	23.708	27.597
April.	58.519	50.250	64.415	26.958	23.709	30.662
May.	58.175	49.915	74.269	26.704	23.570	35.477
June.	56.471	49.034	.....	25.948	23.267	.....
July.	54.678	47.519	.....	25.219	22.597	.....
August.	54.344	47.163	.....	25.979	22.780	.....
September.	53.290	48.680	.....	24.260	23.5½	.....
October.	50.654	49.385	.....	23.199	23.925	.....
November.	49.082	51.714	.....	22.703	25.094	.....
December.	49.375	54.971	.....	22.900	26.373	.....
Year.	54.811	49.634	.....	25.314	23.675	.....

New York quotations cents per ounce troy, fine silver; London, pence per ounce, sterling silver, 0.925 fine.

COPPER

Month	New York		London			
	Electrolytic		Standard		Electrolytic	
	1915	1916	1915	1916	1915	1916
Jan.	13.641	24.008	60.756	88.083	65.719	116.167
Feb.	14.394	26.440	63.494	102.667	*	133.167
Mar.	14.787	26.310	66.152	107.714	*	136.000
April.	16.811	27.895	75.096	124.319	*	137.389
May.	18.506	28.625	77.600	135.457	*	152.622
June.	19.477	.....	82.574	.....	95.333	.....
July.	18.796	.....	76.011	.....	91.409	.....
Aug.	16.941	.....	68.673	.....	82.333	.....
Sept.	17.502	.....	68.915	.....	85.250	.....
Oct.	17.686	.....	72.601	.....	88.000	.....
Nov.	18.627	.....	77.744	.....	93.273	.....
Dec.	20.133	.....	80.773	.....	100.43	.....
Year.	17.275	.....	72.532	.....	.....	.....

TIN

Month	New York		London	
	1915	1916	1915	1916
January.	34.260	41.825	156.550	175.548
February.	37.415	42.717	176.925	181.107
March.	48.426	50.741	180.141	193.609
April.	47.884	51.230	166.225	199.736
May.	38.790	49.125	162 675	196.511
June.	40.288	.....	167.636	.....
July.	37.423	.....	167.080	.....
August.	34.389	.....	151.440	.....
September.	33.125	.....	152.625	.....
October.	33.080	.....	151.554	.....
November.	39.224	.....	167.670	.....
December.	38.779	.....	167.000	.....
Av. year.	38.590	.....	163.960	.....

LEAD

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
January.	3.729	5.921	3.548	5.826	18.606	31.167
February.	3.827	6.246	3.718	6.164	19.122	31.988
March.	4.053	7.126	3.997	7.375	21.883	34.440
April.	4.221	7.630	4.142	7.655	21.094	34.368
May.	4.274	7.463	4.182	7.332	20.347	32.967
June.	5.932	.....	5.836	.....	25.170	.....
July.	5.659	.....	5.531	.....	24.611	.....
August.	4.656	.....	4.520	.....	21.946	.....
September.	4.610	.....	4.490	.....	23.151	.....
October.	4.600	.....	4.499	.....	23.994	.....
November.	5.155	.....	5.078	.....	26.278	.....
December.	5.355	.....	5.266	.....	28.807	.....
Year.	4.673	.....	4.567	.....	22.917	.....

SPELTER

Month	New York		St. Louis		London	
	1915	1916	1915	1916	1915	1916
Jan.	6.386	16.915	6.211	16.745	30.844	89.810
Feb.	8.436	18.420	8.255	18.260	39.819	97.762
Mar.	8.541	16.846	8.360	16.676	44.141	95.048
April.	10.012	16.695	9 837	16.525	49.888	99.056
May.	14.781	14.276	14.610	14.106	68.100	94.217
June.	21.208	.....	21.038	.....	100.614	.....
July.	19.026	.....	18.856	.....	97.250	.....
Aug.	12.781	.....	12.611	.....	67.786	.....
Sept.	13.440	.....	13.270	.....	67.841	.....
Oct.	12.800	.....	12.596	.....	66.536	.....
Nov.	15.962	.....	15.792	.....	88.409	.....
Dec.	15.391	.....	15.221	.....	89.400	.....
Year.	13.230	.....	13.054	.....	67.553	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton. * Not reported.

PIG IRON IN PITTSBURGH

Month	Bessemer‡		Basic‡		No. 2 Foundry	
	1915	1916	1915	1916	1915	1916
January.	$14.59	$21.60	$13.45	$18.78	$13.90	$19.70
February.	14.55	21.16	13.45	18.93	13.90	19.51
March.	14.55	21.81	13.45	19.20	13.95	19.45
April.	14.55	21.65	13.45	18.95	13.95	19.45
May.	14.61	22.20	13.60	19.24	13.83	19.58
June.	14.70	.....	13.67	.....	13.77	.....
July.	14.94	.....	13.91	.....	13.68	.....
August.	16.01	.....	15.31	.....	14.75	.....
September.	16.86	.....	15.95	.....	15.70	.....
October.	16.95	.....	15.96	.....	15.80	.....
November.	17 57	.....	16.47	.....	17.20	.....
December.	19.97	.....	18.44	.....	18.95	.....
Year.	$15.82	.....	$14.76	.....	$14.95	.....

‡As reported by W. P. Snyder & Co.

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